Ontology Engineering: a Survey and a Return on Experience

Fabien Gandon

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INSTITUT DE RECHERCHE EN INFORMATIQUE ET AUTOMATIQUE

ONTOLOGY ENGINEERING: A SURVEY AND A RETURN ON EXPERIENCE

Fabien GANDON

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Ontology Engineering: a Survey and a Return on Experience

Fabien GANDON

ACACIA Team

Thème 3 : Interaction homme-machine, images données, connaissances

Rapport de Recherche n° 4396 - March 2002 - 181 pages

Abstract: Ontology is a new object of IA that recently came to maturity and a powerful conceptual tool of Knowledge Modeling. It provides a coherent base to build on, and a shared reference to align with, in the form of a consensual conceptual vocabulary, on which one can build descriptions and communication acts. This report presents the object that is called "an ontology" and a state of the art of engineering techniques for ontologies. Then it describes a project for which we developed an ontology and used it to improve knowledge management. Finally it describes the design process and discuss the resulting ontology.

Keywords: ontology, knowledge engineering, semantic information search

Ingénierie d'Ontologie: une Synthèse et un Retour d'Expérience

Fabien GANDON

Projet ACACIA

Thème 3 : Interaction homme-machine, images données, connaissances

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Résumé: L'ontologie est un nouvel objet de l'Intelligence Artificielle, qui a récemment atteint sa maturité en devenant un puissant outil conceptuel pour la modélisation de connaissances. L'ontologie fournit une base cohérente sur laquelle construire, et une référence partagée sur laquelle s'aligner, sous forme d'un vocabulaire conceptuel consensuel avec lequel on peut décrire et communiquer. Ce rapport présent l'objet que l'on appelle "une ontologie" et donne un état de l'art des techniques d'ingénierie d'ontologie. Puis il présente un projet pour lequel nous avons développé une ontologie qui fut utilisée pour améliorer la recherche d'information. Pour finir, il décrit le processus de conception et commente les résultats.

Mots-clefs: ontologie, ingénierie des connaissances, recherche sémantique d'informations

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CONTEXT

The last decade information technology explosion led to a shift in the economy and market rules forcing corporations to adapt their organization and management in order to improve their reaction and adaptation times. Information systems became backbones of organizations enabling project-oriented management and virtual teams, therefore the industrial interest in methodologies and tools enabling capitalization and management of corporate knowledge grew stronger.

A corporate memory is an explicit, disembodied and persistent representation of knowledge and information in an organization, in order to facilitate their access, share and reuse by members of the organization, for their tasks [Dieng *et al.*, 2001]. The stake in building a corporate memory management system is the coherent integration of this dispersed knowledge in a corporation with the objective to promote knowledge growth, promote knowledge communication and in general preserve knowledge within an organization [Steels, 1993].

The semantic web technologies provide interesting techniques to materialize and structure memories in order to prepare their exploitation and management. At the same time, distributed artificial intelligence proposes appropriate paradigms, especially the multi-agents one, to deploy a software architecture over this distributed information landscape. Through intelligent collaboration, agents can achieve a global capitalization of the corporate knowledge while being able to locally adapt to individual resources and users' specificity. ACACIA, the research team I belong to, took part in the CoMMA project (IST-1999-12217) funded by the European Commission. CoMMA studied and implemented a prototype for a corporate memory management framework based on several emerging technologies: agents, ontology engineering and knowledge modeling, XML, information retrieval and machine learning techniques [CoMMA, 2000]. The project developed this system in the context of two scenarios: (1) assisting the insertion of new employees in the company and (2) supporting the technology monitoring process.

In these scenarios it is vital to ensure the quality of communication between and among artificial and human agents. An ontology can play the role of the needed semantics grounding for communication and representation of knowledge. Ontology is a new object of IA that recently came to maturity and a powerful conceptual tool of Knowledge Modeling. It provides a coherent base to build on, and a shared reference to align with, in the form of a consensual conceptual vocabulary, on which one can build descriptions and communication acts. By making explicit the so often implicit conceptualization of the world, ontologies enable us to capture consensus, formalize knowledge and exchange it. Even if it is only partial, this explicit conceptualization enables us to simulate intelligence in artificial actors of information spaces.

After introducing the problems for which we use ontologies we will briefly present the object "ontology" and the notions used to define that object. Then we present the different a state of the art on ontology engineering that inspired our work. Next we briefly present the context of the CoMMA project for which the O'CoMMA ontology was needed. The following part explains step-by-step how the first version of O'CoMMA was built. Finally, the last section presents and discusses the results of this experience.

Note: Quotations are given in italic without quotes, to enable fluid reading of the text.

Chapter 1 : THE NEEDS FOR ONTOLOGY

1.1 General problematics addressed by ontologies.

People, organizations and software systems must communicate between and among themselves. However, due to different needs and background contexts, there can be widely varying viewpoints and assumptions regarding what is essentially the same subject matter. Each uses different jargon; each may have differing, overlapping and/or mismatched concepts, structures and methods [Uschold and Gruninger, 1996]. Some of the consequences of a lack of a shared understanding are: poor communication, difficulties in identifying requirements and therefore in specifying a system, limited inter-operability, limited potential of reusability and sharing, therefore wasted efforts in re-inventing the wheel. There is a need to *reduce or eliminate conceptual and terminological confusion and come to a shared understanding*. (...) the *development and implementation of an explicit account of a shared understanding (i.e. an 'ontology') in a given subject area, can improve such communication, which in turn can give rise to greater reuse and sharing, inter-operability, and more reliable software* [Uschold and Gruninger, 1996]. For Uschold and Gruninger, an ontology is a unifying framework for different viewpoints and serves as the basis for enabling communication (between people, between people and systems, between systems): this unifying conceptual framework is intended to function as a lingua-franca.

Ontologies are to semantics, what grounding is to electronic: a common base to build on, and a shared reference to align with. Ontologies are considered as a powerful tool to lift ambiguity: one of the main roles of ontologies is to disambiguate, providing a semantic ground, a consensual conceptual vocabulary, on which one can build descriptions and communication acts. *On the one hand, ontologies provide conceptual and notional resources to formulate and make explicit knowledge (...) On the other hand, they constitute a shared framework that different actors can mobilize and where they all can find their bearings (...) Finally, they can represent the meaning of different contents exchanged in information systems.* [Bachimont, 2001]

[Mizoguchi *et al.*, 1997] explains in one sentence what is the challenge facing the ontology engineering field: *Most of the conventional software is built with an implicit conceptualization. The new generation of AI systems should be built based on a conceptualization represented explicitly.* In fact by making at least some aspects of our conceptualizations explicit to the systems we can improve them through inferences exploiting this explicit partial conceptualizations of our reality.

Sowa [2000] quotes the New Essays on Human Understanding of Gottfried Wilhelm von Leibniz saying that *the art of ranking things in genera and species is of no small importance and very much assists our judgment as well as our memory. (...) This helps one not merely to retain things, but also to find them. And those who have laid out all sorts of notions under certain headings or categories have done something very useful.*

The more we develop intelligent information systems, the more the general knowledge about things and their categories appears to play a pivotal role in inferences. Therefore this knowledge needs to be given to the machines if we want them to behave intelligently and intelligibly.

1.2 An example of problem where ontologies proved to be useful.

In order to exemplify the previous statements, we will take examples from the context of the work reported here: information retrieval. The general problem is to formulate a query over a mass of information and get an answer as precise and relevant as possible.

In her tutorial at ECAI 98, Assunción Gómez-Pérez asked :

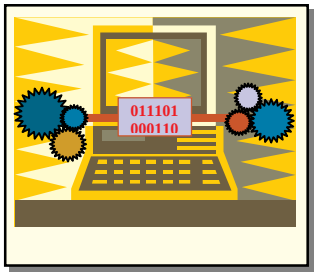
"**What is a pipe ?**"

Extending her example we can imagine three answers to this very same question.

Indeed, there exists at least three notions behind the word "pipe":

A short narrow tube with a small container at one end, used for smoking eg. tobacco.

A long tube made of metal or plastic that is used to carry water or oil or gas.



A temporary section of computer memory that can link two different computer processes.

We have one term and three concepts, it is a case of ambiguity. The contrary is one concept behind several terms, and it is a case of synonyms e.g. car, auto, automobile, motorcar, etc. These trivial cases poses a serious problem to computerize systems that are not able the see these difference or equivalence unless they have been made explicit to it.

Let's take the example of a classic user of the Altavista search engine looking for books by Ernest Hemingway: the usually chosen keywords would be "+book +hemingway". The search engine will encounter several types of problems:

- Noise: a problem of precision that will lead the search engine to collect a page with the sentence "The Old Book Pub, 3 Avenue Hemingway" while it is obvious to us that this is not relevant.
- Missed answer: a problem of recall where the search engine misses a page containing a sentence such as "The novel 'The Old Man and The Sea' by Ernest Hemingway" because it does not know the basic categories of documents, and therefore does not know that a novel is a book.

If we look at the way a human does answer a question, we may find interesting leads to solve the problem. Consider this little speech between two persons:

Person A: "what is the last document you read ?"

Person B: "the article Gruber wrote on ontology in 1993."

The answer given by person B is based on an organization of concepts used for at least two purposes:

- Identification: the ability to recognize an object, an action, etc. as belonging to a category e.g. the ability to recognize an object as being a "book" and an action as being "reading"
- Specialization and generalization: the ability to memorize abstractions of categories in hierarchies of specialization/generalization e.g. : "an article, a book, a newspaper, etc. are documents", "a novel is a book". These hierarchies are the basis of inferences at the heart of information retrieval and exchange e.g. : the syllogism "a novel is a book" "a book is a document" so "a novel is a document".

This structure of categories is learnt through education and social cultural interactions. For instance imagine the following situation:

A familly is on the road for holidays. The child sees a horse by the window, it is the first time he sees a horse:

"Look mum... it is a big a dog !".

The mother looks and recognizes a horse :

"No Tom, it is a horse... see it's much bigger !"

The child will adapt his categories an take notes of the differences he perceives or he is told to differentiate this new categories from others. A few kilometers later the child sees a donkey for the first time:

"Look mum... another horse !"

The mother looks and recognizes the donkey :

"No Tom, it is a donkey... see it's a little bit smaller, it is gray..." and so on.

In these interactions, categories are learnt, exchanged and aligned. This will enable understanding in the future when they will be used for communication.

Thus this structure in hierarchical categories captures a consensus and is socially and culturally dependent. If there is a mismatch or a lack, an interaction will take place to align the two opinions or fill the gap as in the example of the child. The consensus is implicit : in the case of the interactions about the document both speakers implicitly consider that they have a shared and consensual conceptualization of the reality of documents. By answering with "article" the second speaker considers that the first speakers knows that "an article is a document".

This background knowledge is lacking in information systems relying only on terms and plain-text search. A possible approach is thus to make this knowledge explicit and capture it in logical structures that can be exploited by automated systems. This is exactly the purpose of an ontology: to captures the semantics and relations of the notions we use, make them explicit and eventually code them in symbolic systems so that they can be manipulated and exchanged.

Chapter 2 : AN OBJECT CALLED "ONTOLOGY"

2.1 Basis Definitions

The word ontology comes from the Greek ontos for being and logos for word. It is a relatively new term in the long history of philosophy, introduced by the 19th century German philosophers to distinguish the study of being as such from the study of various kinds of beings in the natural sciences. The more traditional term is Aristotle's word category (kathgoria), which he used for classifying anything that can be said or predicated about anything. [Sowa, 2000b]

The word ontology can be used and has been used with very different meanings attached to it. Ironically, the ontology field suffered a lot from ambiguity. The Knowledge Engineering Community borrowed the term 'Ontology' from the name of a branch of philosophy some 15 years ago and converted into an object: an 'ontology'. In the mid-90s philosophers 'took it back' and began to clean the definitions that had been adopted.

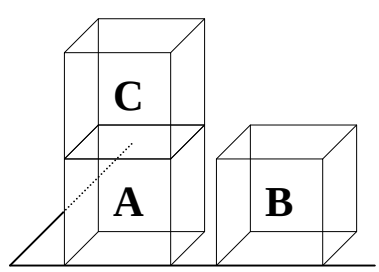
Therefore before any consideration of the ontology engineering activity, I will give some of the latest definitions proposed in the knowledge engineering community and adopted in this report. I added personal definitions and dictionary definitions of notions commonly used in the field.

Notion:	something formed in the mind, a constituent of thought || it is used to structure knowledge and perceptions of the world || principle, idea semantically evaluable and redeployable
A concept:	notion usually expressed by a term (or more generally by a sign) || the concept represents a group of objects or beings having shared characteristics t that enable us to recognize them a forming and belonging to this group.
A relation:	notion of an association or a link between concepts usually expressed by a term or a graphical convention (or more generally by a sign)
Extension / Intension:	distinction between ways in which a notion may be regarded: its extension is the collection of things to which the notion applies; its intension is the set of features those things are presumed to have in common.
Concept in intension / Intension of a concept:	set of attributes, characteristics or properties shared by the object or beings included in or to which the concept applies. e.g. for the concept of a "car" the intension includes the characteristics of " a road vehicle with an engine, usually four wheels and seating for between one and four people."
Concept in extension / Extension of a concept:	set of objects or beings included in or to which the concept applies. e.g. for the concept of a "car" the extension includes: "the Mazda MX5 with the registration 2561 SH 45", the "green car parked at the corner of the road in front of my office" ...
Relation in intension / Intension of a relation:	set of attributes, characteristics or properties that characterizes every realization of a relation. e.g. for the relation "parenthood" the intension includes the characteristics of "the raising of children and all the responsibilities and activities that are involved in it"
Signature of a relation	set of concepts that can be linked by a relation, this constraint is a characteristic of the relation that participate to the definition of its intension. e.g. for the relation "parenthood" the signature says it is a relation between two members of the same species
Relation in extension /	set of effective realizations of a relation between object or beings.

Extension of a relation:	e.g. for the relation "parenthood" the extension includes: "Jina and Toms are the Parents of Jim", the "Mr Michel Gandon is my Father" ...
Ontology:	*that branch of philosophy which deals with the nature and the organization of reality* [Guarino and Giaretta, 1995]. || a branch of metaphysics which investigates the nature and essential properties and relations of all beings as such.
Formal Ontology:	*the systematic, formal, axiomatic development of the logic of all forms and modes of being* [Guarino and Giaretta, 1995].
Conceptualization:	*an intensional semantic structure which encodes the implicit rules constraining the structure of a piece of reality* [Guarino and Giaretta, 1995] || it also denotes the action of building such a structure.
An ontology:	*a logical theory which gives an explicit, partial account of a conceptualization* [Guarino and Giaretta, 1995] || *The aim of ontologies is to define which primitives, provided with their associated semantics, are necessary for knowledge representation in a given context.* [Bachimont, 2000]
Ontological commitment:	*a partial semantic account of the intended conceptualization of a logical theory* [Guarino and Giaretta, 1995] || *Practically, an ontological commitment is an agreement to use a vocabulary (i.e. ask queries and make assertions) in a way that is consistent with respect to the theory that specifies the ontology. We build agents that commit to ontologies and we design ontologies so that we can share knowledge with and among these agents.* [Uschold and Gruninger, 1996]
Ontological theory:	*a set of formulas intended to be always true according to a certain conceptualization* [Guarino and Giaretta, 1995].
Ontological engineering:	*the branch of knowledge engineering which exploits the principles of (formal) Ontology to build ontologies* [Guarino and Giaretta, 1995]. || *Defining an ontology is a modeling task based on the linguistic expression of knowledge.* [Bachimont, 2000]
Ontologist:	a person who builds ontologies or whose job is connected with ontologies' science or engineering.
State of affairs:	the general state of things, the combination of circumstances at a given time. The ontology can provide the conceptual vocabulary to describe a state of affairs. Together this description and the state of affair form a model.
A taxonomy:	a classification based on similarities.
Mereology:	The study of part-whole relationships.
A partonomy:	a classification based on part-of relation.

2.2 Beyond definitions

To exemplify these definitions, we can reuse the well-known situation of cubes on a table. Figure 1 shows a schema depicting the real scene of three cubes being arranged on a table. A conceptual vocabulary (toy ontology) is proposed to talk about some aspects of this reality (some of them are ignored, for instance there is no vocabulary to express the dimensions of the cubes). Finally the state of affairs of the scene observed is described using the primitives of the ontology.



Cube (X): The entity X is a right-angled parallelepiped with all its edges of equal length.
Table: A global object which is a furniture composed of an horizontal flat top put down on one or more legs.
On (Cube: X, Cube: Y / Table): a relation denoting that a cube X is on top of another Cube Y or on top of the Table

```
Cube (A)
Cube (B)
Cube (C)
On(A,Table)
On(C,A)
On(B,Table)
```

a - Reality **b** - Ontology **c** - Describe State of Affairs

Figure 1 The example of cubes

This example illustrates the definition of an ontology:

The ontology is...	**Because...**
an explicit	the colon b explicit the concepts used here
partial account	some aspect were overlooked e.g. : the dimensions of the cubes, their material, etc.
of a conceptualization	we recognize in this reality some entities (cube, table, etc.) some rules (spatial relations, geometry, labeling of cubes etc.)

It is important to stress that nothing, in the original definition of an ontology - *an ontology is a specification of a conceptualization* [Gruber, 1993] - nor in the definition we gave above, obliges the ontologist to use a formal language to make the ontology explicit. However the automated exploitation of an ontology by an artificial system may imply some formalization of some chosen aspects of the ontology to enable the formal manipulation of those aspects.

Since an ontology captures concepts, It is a massive collection of *Peirce's three kinds of signs: icons, which show the form of something; indices, which point to something; and symbols, which represent something according to some convention*. [Sowa, 2000]. For instance the concept of 'fire' can be represented by signs such as in Figure 2:


icon

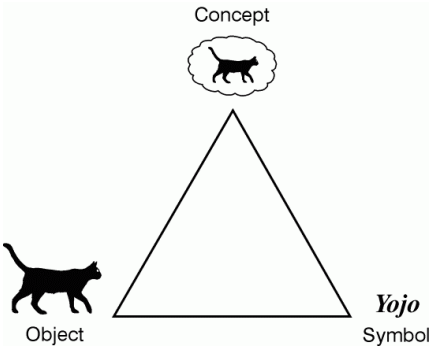

index

symbol

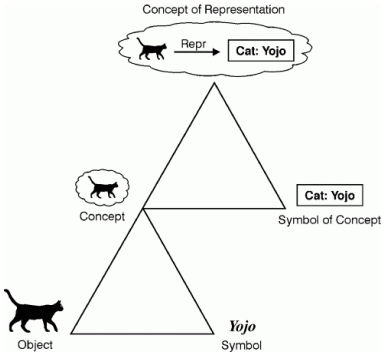
Figure 2 Icon, Index and Symbol

Meaningless data cannot acquire meaning by being tagged with meaningless metadata. The ultimate source of meaning is the physical world and the agents who use signs to represent entities in the world and their intentions concerning them (...) without the people, the document and its contents have no meaning. [Sowa, 2000] (...) *current proposals for ontologies and metadata have overlooked some of the most important features of signs. A sign has three aspects: it is (1) an entity that represents (2) another entity to (3) an agent*.

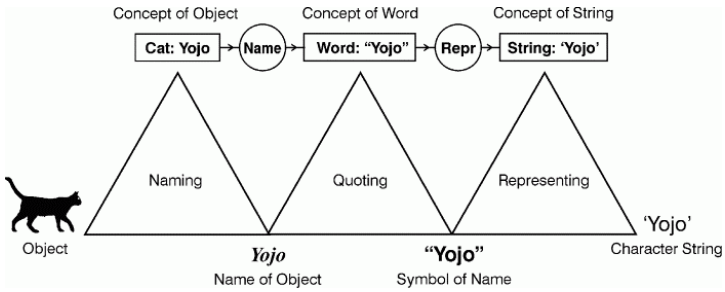
Sowa [2000], using the meaning triangle of Ogden and Richards, explains the fact that we use signs to name objets according to a conceptualization. The very same triangle can be composed as shown in Figure 3 to illustrate the process of abstraction or the process of representing and coding.



(a) Naming



(b) Abstraction



(c) Coding

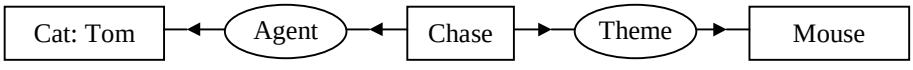
Figure 3 Composition of meaning triangles [Sowa, 2000]

The usual example from Fredge is the terms "morning star" and "evening star" are different signs *creating different concepts in the mind of the listener. Both concepts stand for the same object, but in respect to a different ground, which depends on the time of the observation.* [Sowa, 2000]

Pure logic is ontologically neutral. It makes no presuppositions about what exists or may exist in any domain or any language for talking about the domain. To represent knowledge about a specific domain, it must be supplemented with an ontology that defines the categories of things in that domain and the terms that people use to talk about them. The ontology defines the words of a natural language, the predicates of predicate calculus, the concept and relation types of conceptual graphs, the classes of an object-oriented language, or the tables and fields of a relational database. [Sowa, 2000]

Sowa [2000] gives the following example represented here in logic and conceptual graphs [Sowa,19984]. The fact represented here is "Tom the cat is chasing a mouse".

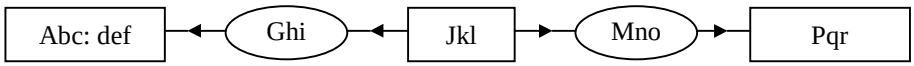
$(\exists x: Cat) (\exists y: Chase) (\exists z: Mouse)$ (Identifier(x , "Tom") $\wedge$ Agent(y , x) $\wedge$ Theme(y , z))



This formula and the conceptual graphs introduce several ontological assumptions: there exist entities of types Cat, Chase, and Mouse; some entities have character strings as names; and Chase can be linked to concepts of other entities by relations of type Agent and Theme. Sowa [2000]

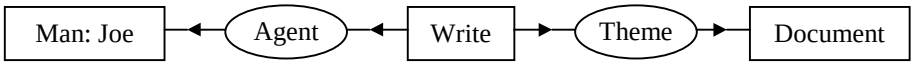
To show that the logic does not captures the meaning of the primitives and that we interpret the meaning of the primitives because they are words of our natural language. Lets consider the following formulae and graphs:

(∃ x: Abc) (∃ y: Jkl) (∃ z: Pqr) (Stu(x , "def") ∧ Ghi (y , x) ∧ Mno(y , z))



They are logically equivalent to the one of "Tom the cat is chasing a mouse", but without any interpretation possible because the primitives have lost the ontological meaning we were able to find using natural language. These very same formulae could mean "The man Joe is writing a document":

(∃ x: Man) (∃ y: Write) (∃ z: Document) (Identifier(x , "Joe") ∧ Agent(y , x) ∧ Theme(y , z))



An uninterpreted logic is ontologically neutral: It imposes no constraints on the subject matter or the way the subject is characterized. By itself, logic says nothing about anything, but the combination of logic with an ontology provides a language that can express relationships about the entities in the domain of interest. [Sowa, 2000b]

By maintaining human understandable representations of the notions, the ontology captures the isomorphism between the symbolic system used for artificial intelligence simulation and the observations of the real world viewed from the perspective of the adopted conceptualization. By capturing this isomorphism we intend to capture an advocated consensual interpretation for the users of the system. The most advanced symbolic systems are logical systems and derived knowledge representation languages of all sorts.

In this report we shall thus focus on the branch of Knowledge representation that applies logic and ontology to the task of constructing computable models for some application domain.

The taxonomy is one of the possible structuring for an ontology, it is a form of logical theory. Its importance comes from the fact if supports elementary inferences constantly at play in information searching and communicating processes. *The oldest known tree diagram was drawn in the 3rd century AD by the Greek philosopher Porphyry in his commentary on Aristotle's categories.* Figure 4 *shows a version of the Tree of Porphyry, as it was drawn by the 13th century logician Peter of Spain. It illustrates the subcategories under Substance, which is called the supreme genus or the most general supertype*. [Sowa, 2000b]

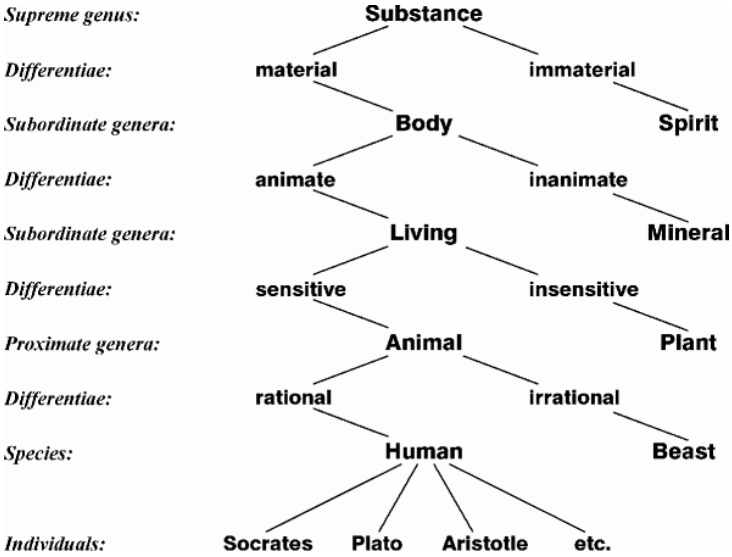


Figure 4 Tree of Aristotle's categories drawn by Porphyry

Aristotle introduced the term differentia (diafora) for the properties that distinguish different species of the same genus.(...) Sowa [2000b] explains that the technique of inheritance is the process of merging all the differentiae along the path above any category for instance

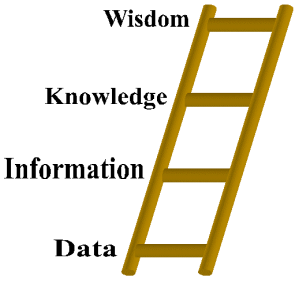
Human = rational sensitive animate material Substance.

Aristotle's method of defining new categories by genus and differentiae is fundamental to artificial intelligence, object-oriented systems, the semantic web, and every dictionary from the earliest days to the present. [Sowa, 2000b] The link from a genus to a new category is called the subsumption link, the specialization/generalization link, the subtype-supertype link, etc. It sets up a partial ordering of categories, concepts or classes.

Sowa [2000b] distinguishes between a terminological ontology and a formal ontology. They are the two extreme of a continuum: as more axioms are added to a terminological ontology, it may evolve into a formal or axiomatized ontology.

What is the place / position of ontology in knowledge ? If we take the ladder of understanding used in the librarian community, we can propose some definitions of data, information and knowledge. These definitions can be built bottom-up or top-down:

Starting from the bottom we can define data as a perception, a signal, a sign or a quantum of interaction (e.g. '40' or 'T' are data). Information is data structured according to a convention (e.g. T=40°). Knowledge is information with a context and value that make it usable (e.g. "the patient of the room 313 of the Hospital of Orleans has a temperature T=40°"). As an anecdote wisdom can be defined as timeless knowledge.



Starting from the top information can be defined as knowledge expressed according to a convention. Data can be defined as the basic element of information coding.

If we consider now the sentence "children are young humans". The context is not clear yet this is perfectly intelligible, perfectly usable, this is knowledge. In fact the context here is general: it is knowledge about a category of things and not a about a specific occurrence of a concept. Thus this knowledge is, in the human culture, universally verified. This is typically an ontological piece of knowledge.

This knowledge could be encoded in a taxonomy to be exploited by a system, e.g.:

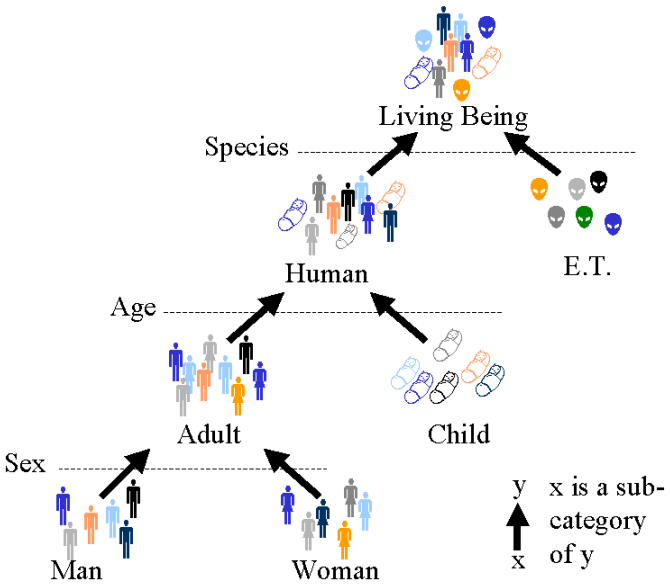


Figure 5 Toy taxonomy of Living beings.

But an ontology is not a taxonomy. Other logical theories are useful to capture the definitional characteristics of the concepts we manipulate. For instance, the concepts of chemical elements make extensive use for their definition of partonomies:

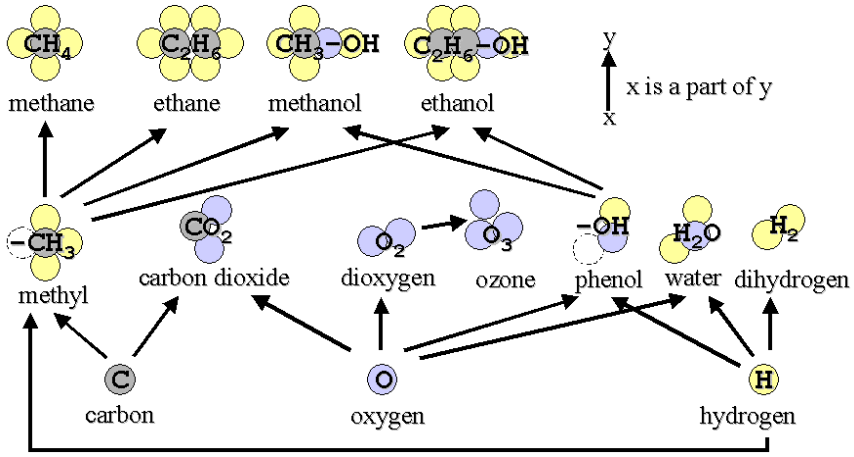


Figure 6 Toy partonomy of chemical elements

And partonomies are not the unique alternative to taxonomies. Further logical formalizations can be done especially to enable further inference capabilities such as automatic classification of new categories or identification of objects e.g.:

$$\text{director}(x) := \text{person}(x) \wedge (\exists y\ \text{organization}(y) \wedge \text{manage}(x,y))$$

Or to capture causal models e.g.:

$$(\text{salty things} \Rightarrow \text{thirst}) \wedge (\text{thirst} \Rightarrow \text{to drink})\ \textbf{thus}\ (\text{salty things} \Rightarrow \text{to drink})$$

Sometimes instances can be included in ontologies they could be called universal instances. For instance constants (c the speed of light, g,...) or global objects (the activity "the research") to enable a unique reference to the object. But this is not the real purpose of ontologies: they should concentrate on universal concepts and reify them if the need comes to use these concepts as object of the discourse. For a complete discussion on this point, see the working notes of Nicolas Guarino at the AAAI Spring Symposium on Ontological Engineering, held in Stanford in March 1997.

This concludes our light introduction to the "ontology" object. In the following chapter we will concentrate on the design of an ontology.

Chapter 3 : LIFE CYCLE OF AN ONTOLOGY

3.1 A living object with a maintenance cycle

In [Dieng *et al.*, 2001] my colleagues from ACACIA discussed the life cycle of a corporate memory:

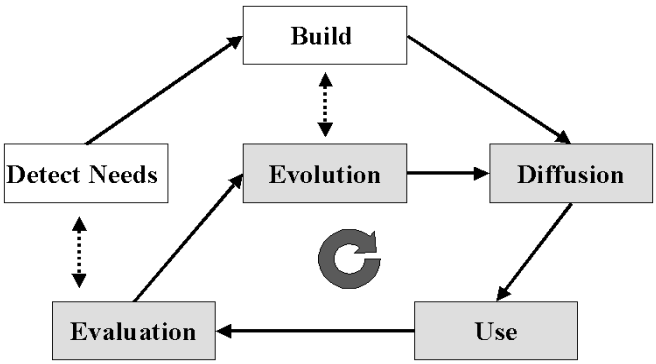


Figure 7 Life-cycle of a corporate memory

When an ontology participate to a knowledge modeling as the one of a corporate memory, it becomes a full component of the model. It is also subject to its life cycle since evolutions of the modeling needs may imply evolutions of the modeling primitives provided by the ontology.

The design of an ontology is an iterative maturation process. This means the ontology will be coming to full development, becoming mature, by evolving through intermediate states to reach a desired or final condition.

As soon as the ontology becomes important, the ontology engineering process has to be considered as a project, and therefore project management methods must be applied. [Fernandez *et al.*, 1997] recognized that planning and specification are important activities. The authors give the *activities to be done during the ontology development process. They are: planify, specify, acquire knowledge, conceptualize, formalize, integrate, implement, evaluate, document, and maintain.* (c.f. Figure 8)

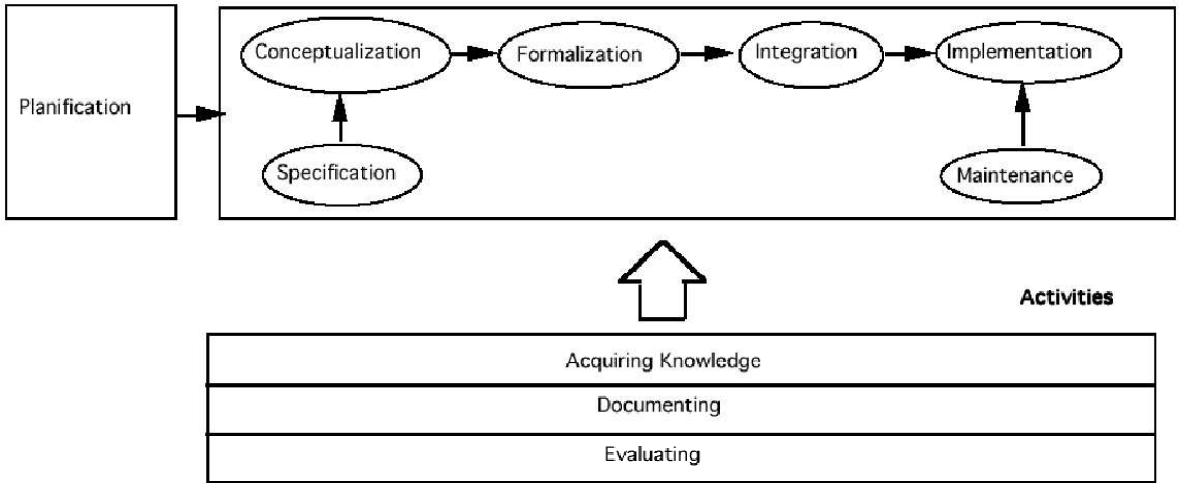


Figure 8 States and activities in the ontology life-cycle [Fernandez *et al.*, 1997]

[Fernandez *et al.*, 1997] criticizes the waterfall and the incremental life cycles and proposes to use the evolving prototype life cycle that lets the ontologist modify, add, and remove definitions in the ontology at any time. The authors explain that *the life of an ontology moves on through the following states: specification, conceptualization, formalization, integration, implementation, and maintenance. The evolving prototype life cycle allows the ontologist to go back from any state to other if some definition is missed or wrong. So, this life cycle permits the inclusion, removal or modification of definitions anytime of the ontology life cycle. Knowledge acquisition, documentation and evaluation are support activities that are carried out during the majority of these states.*

When applied to a changing domain, the ontology will have to evolve. *Anytime, anywhere, someone could ask for including or modifying definitions in the ontology. To maintain the ontology is an important activity to be done carefully. Guidelines for maintaining ontologies are also needed.* [Fernandez *et al.*, 1997]

Merging the two previous life-cycle diagrams we can propose the following cycle:

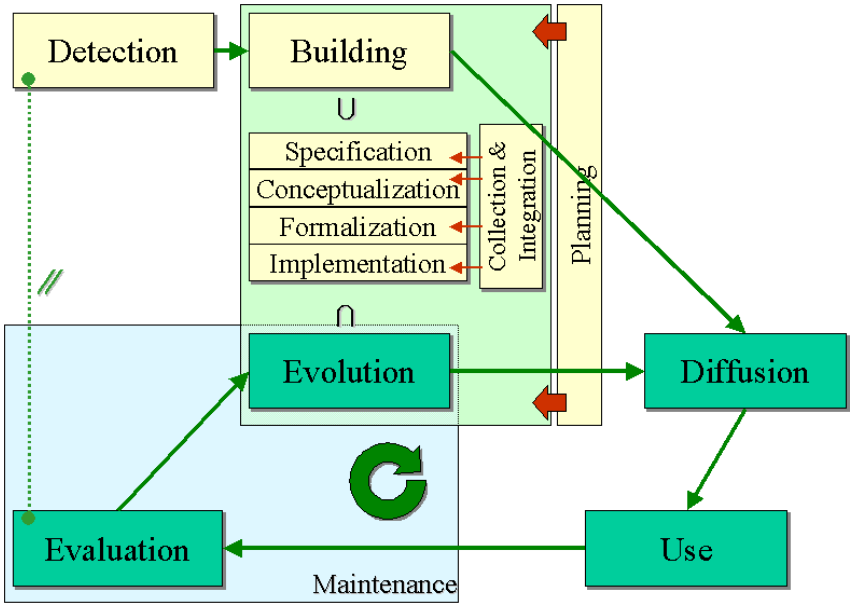


Figure 9 Merged cycles

The activities described in the rest of this chapter participate to this life cycle progress. However, even if a full investigation of consequences is out of the scope of this document, it must be noticed that ontology maintenance has consequences beyond the ontology life-cycle. It impacts everything that was built using this ontology. A software where the ontology was hardwired has to be versioned, knowledge bases coherence has to be maintained, etc. So although the problem of the ontology evolution itself is a hard one, one should consider the fact that ontologies provide building blocks for modeling and implementation. What happens to the elements that were built thanks to these building blocks when a change occurs in the ontology? (e.g. Add a concept, Delete a concept, Modify a concept, Modify hierarchy, Add a relation, Delete a relation, Modify a relation).

Ontology design is a project, and should be treated as such, especially when it becomes large. Project Management and software engineering techniques and guidelines should be adapted and applied to ontology engineering. Scenarios are especially interesting as a starting point to build use cases and interaction diagrams. [Fernandez *et al.*, 1997] stresses that *before building your ontology, you should plan the main tasks to be done, how they will be arranged, how much time you need to perform them and with which resources (people, software and hardware).*

3.2 Introduction to the ontology engineering field

3.2.1 Engineering an ontology

Ontology in philosophy contributes to understanding of the existence. While it is acceptable as science, its contribution to engineering is not enough, it is not for ontology engineering which has to demonstrate the practical utility of ontology. It is true that every software has an ontology in itself and every president of a company has his/her own ontology of enterprise. But, such an ontology is ***implicit****. An* ***explicit*** *representation of ontology is critical to our purpose of making computers 'intelligent'. (...) the ultimate purpose of ontology engineering is: 'To provide a basis of building models of all things, in which information science is interested, in the world'.* [Mizoguchi *et al.*, 1997]

The philosophical discipline of Ontology is evolving towards an engineering discipline, and in this evolution the need for a principled methodology has clearly arisen [Guarino and Welty, 2000].

Although the world is bigger than any human can comprehend or any computer can compute, the set of all possible theories and models is even bigger. The entire universe contains a finite number of atoms, but the number of all possible theories is countably infinite, and the number of possible models of those theories is uncountably infinite. The ultimate task of science is to search that vast infinity in the hope of finding a theory that gives the best answers to all possible questions. Yet that search may be in vain. Perhaps no single theory is best for all questions; even if one theory happened to be the best, there is no assurance that it would ever be found; and even if somebody found it, there might be no way to prove that it is the best. [Sowa, 2000b]

Engineers have a more modest goal. Instead of searching for the best possible theory for all problems, they are satisfied with a theory that is good enough for the specific problem at hand. When they are assigned a new problem, they look for a new theory that can solve it to an acceptable approximation within the constraints of available tools, budgets, and deadlines. Although no one has ever found a theory that can solve all problems, people everywhere have been successful in finding more or less adequate theories that can deal with the routine problems of daily life. As science progresses, the engineering techniques advance with it, but the engineers do not have to wait for a perfect theory before they can do their work.

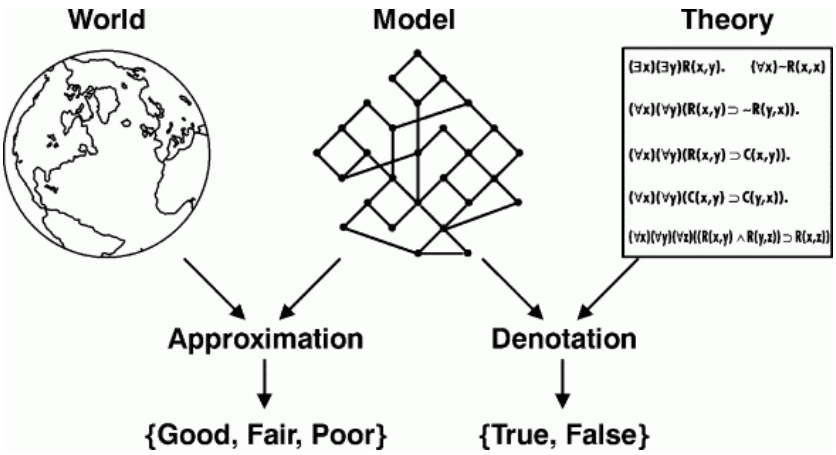


Figure 10 World, Model and Theory [Sowa, 2000b]

To bridge the gap between theories and the world, Figure 10 shows models as Janus-like structures, with an engineering side facing the world and an abstract side facing the theories. On the left is a picture of the physical world, which contains more detail and complexity than any humanly conceivable model or theory can represent. In the middle is a mathematical model that represents a domain of individuals D and a set of relations R over D. On the right of the figure are the axioms of a theory that describes the world in terms of the individuals and relations in the model. If the world had a unique decomposition into discrete objects and relations, the world itself would be a universal model, of which all accurate models would be subsets. But as the examples in this book have shown, the selection of a domain and its decomposition into objects depends on the intentions of some agent and the limitations of the agent's measuring instruments. Even the best models are approximations to a limited aspect of the world for a specific purpose. Engineers express that point in a pithy slogan: All models are wrong, but some are useful. [Sowa, 2000b]

In the following part we will investigate the activities involved in designing an ontology and participating in the ontology life-cycle. Several guidelines and methods have been proposed to design ontologies. We will try to give an overview of different options proposed so far and to conciliate wherever possible the different contributions.

3.3 Scope and Granularity: the use of scenarios for specification

Y*ou should not start the development of your ontology without knowing its purpose and scope* [Fernandez *et al.*, 1997] and in order to identify these goals and the limits of an intervention, one has to answer the question: *why the ontology is being built and what its intended uses are (...) it will also be useful to identify and characterize the range of intended users of the ontology* [Uschold and Gruninger, 1996]. Then one should *specify or write the answers in an ontology requirements specification document.* [Fernandez *et al.*, 1997]

An interesting technique is the one of scenario analysis as presented for example in [Caroll, 1997] and used for software engineering. Scenarios are used as the entrance point in the project, they are usually information-rich stories capturing problems and wishes. [Uschold and Gruninger, 1996] uses the notion of motivating scenarios: *The development of ontologies is motivated by scenarios that arise in the applications (...). The motivating scenarios are story problems or examples which are not adequately addressed by existing ontologies. A motivating scenario also provides a set of intuitively possible solutions to the scenario problems. These solutions provide an informal intended semantics for the objects and relations that will later be included in the ontology. Any proposal for a new ontology or extension to an ontology should describe one or more motivating scenarios, and the set of intended solutions to the problems presented in the scenarios. (…) By providing a scenario, we can understand the motivation for the prior ontology in terms of its applications.*

In [Caroll, 1997] the author proposes to base the system design activity upon scenario descriptions. Caroll wrote that a substantial amount of research and development activity *is focused on creating a more use-oriented perspective on the design and development of computer systems. One key element in this perspective is the user interaction scenario, a narrative description of what people do and experience as they try to make use of computer systems and applications. Computer systems and applications can be viewed, and should be viewed as transformations of the user's tasks and their supporting social practices. In this sense, user interaction scenarios are a particularly pertinent medium for representing, analyzing and planning how a computer system might impact its user's activities and experiences.* This can be reformulated in a broader remark: scenarios are a relevant medium for representing, analyzing and planning how a system might impact its stakeholders' activities and experiences.

Caroll recognizes that *the defining property of a scenario is that it projects a concrete narrative description of activity that the user engages in when performing a specific task, a description sufficiently detailed so that design implications can be inferred and reasoned about. Using scenarios in system development helps keep the future use of the envisioned system in view as the system is designed and implemented; it makes use concrete (which makes it easier to discuss use and design use). (...) Scenarios seek to be concrete; they focus on describing particular instances of use, and on user's view of what happens, how it happens, and why. Scenarios are grounded in the work activities of prospective users; the work users do drives the development of the system intended to augment this work. Thus scenarios are often open-ended and fragmentary; they help developers and users pose new questions, question new answers, open up possibilities. It is not a problem if one scenario encompasses, extends, or depends upon another; such relations may reveal important aspects of use. They can be informal and rough, since users as well as developers may create and use them, they should be as colloquial, and as accessible as possible. They help developers and their users envision the outcomes of design -an integrated description of what the system will do and how it will do it- and thereby better manage and control these outcomes.*

Scenarios have the advantage to enable communication in natural language while capturing situation and context, stakeholders, problems and solutions with their associated vocabulary. In [Uschold and Gruninger, 1996] is introduced the informal competency questions: *Given the motivating scenario, a set of queries will arise which place demands on an underlying ontology. We can consider these queries to be expressiveness requirements that are in the form of questions. An ontology must be able to represent these questions using its terminology, and be able to characterize the answers to these questions using the axioms and definitions. (…) Ideally, the competency questions should be defined in a stratified manner, with higher level questions requiring the solution of lower level questions. (…) The competency questions specify the requirements for an ontology and as such are the mechanism for characterizing the ontology design search space. The questions serve as constraints on what the ontology can be, rather than determining a particular design with its corresponding ontological commitments. There is no single ontology associated with a set of competency questions.*

Scenario analysis, as many other activities in ontology engineering, is not a one-off activity but will be pursued during the whole ontology design process and life-cycle. New scenarios will arise, existing scenarios will be refined. [Fernandez *et al.*, 1997] also notes that the inspection of glossary terms (lexicons) without looking into the details of the definitions can help at that stage to define the scope of the ontology. We shall see that this is closely related to the middle-out perspective of ontology engineering.

Inspired by [Charlet *et al.*, 2000] Granularity:

Man: Human / Woman: Human : we know there exists two different concepts below human

Man: Human-Characteristic - Male / Woman Human - Characteristic - Female: Two concepts with different characteristics

Man: Human - Attribute - Sex - Value - Male / Human - Attribute - Sex - Value - Female: Two concepts sharing the characteristic of having a sex attribute but having a different value for this attributes

3.4 Data collection & Knowledge Acquisition

Data collection is a typical activity from knowledge acquisition community. It is collection-analysis cycle where collection is analyzed and analysis triggers new collection. Several techniques exist for data collection and benefit from work in knowledge acquisition. These techniques are not only used to feed the whole modeling that includes building the ontology and the state of affairs (c.f. section on enterprise modeling) but also to build the knowledge bases (see for example [Dieng, 1990], [Dieng, 1993] and [Dieng, 1998] as well as [Sebillotte, 1991], [La France, 1992] and [Aussenac, 1989]).

3.4.1 Collection process

The elicitation techniques are typically associated with bottom-up approaches whereas, as will shall see with the work of [Fernandez *et al.*, 1997], they influence in fact the whole process of system engineering and maintenance, and different techniques may be useful at different stages of the process.

Elicitation techniques help elicit knowledge: *experts, books, handbooks, figures, tables and even other ontologies are sources of knowledge from which the knowledge can be elicited using in conjunction techniques such as: brainstorming, interviews, formal and informal analysis of texts, and knowledge acquisition tools.* [Fernandez *et al.*, 1997]

One of the main principle of data collection for ontology engineering is to *never prevent users from saying what they want to say, but encourage them to say things in a way that it is easy to work with.* [Uschold and Gruninger, 1996]. The authors used for example brainstorming sessions *to produce all potentially relevant terms and phrases; at this stage the terms alone represent the concepts, thus concealing significant ambiguities and differences of opinion. (…)*

The techniques used in [Fernandez *et al.*, 1997] for the knowledge acquisition of a chemical ontology were:

- *Non-structured interviews with experts, to build a preliminary draft of the requirements specification document.*
- *Informal text analysis, to study the main concepts given in books and handbooks. This study enables you to fill in the set of intermediate representations of the conceptualization.*
- *Formal text analysis. The first thing to do is to identify the structures to be detected (definition, affirmation, etc.) and the kind of knowledge contributed by each one (concepts, attributes, values, and relationships).*
- *Structured interviews with experts to get specific and detailed knowledge about concepts, their properties and their relationships, to evaluate the conceptual model once the conceptualization activity has been finished, and to evaluate implementation.*

It should be noticed that among the documents studied during data collection, there can be existing terminologies or even ontologies collected from the domain. This will then lead to the process of integrating other ontologies in the ontology being built. As we shall see, a given source can be exploited in one or more of the perspectives adopted for ontology engineering depending on the nature of the source. For example interviews are prone to bottom-up and middle-out perspectives, whereas integrating ontologies leads to top-down and middle-out perspectives.

The data collection is not only a source of raw material: for example *interviews to expert might help you to build concept classification trees and to contrast them against figures given in books* [Fernandez *et al.*, 1997]. To structure the taxonomy, one can encourage the interviewee to generalize or specialize the concepts identified, thus deriving valuable leads for the ontology building.

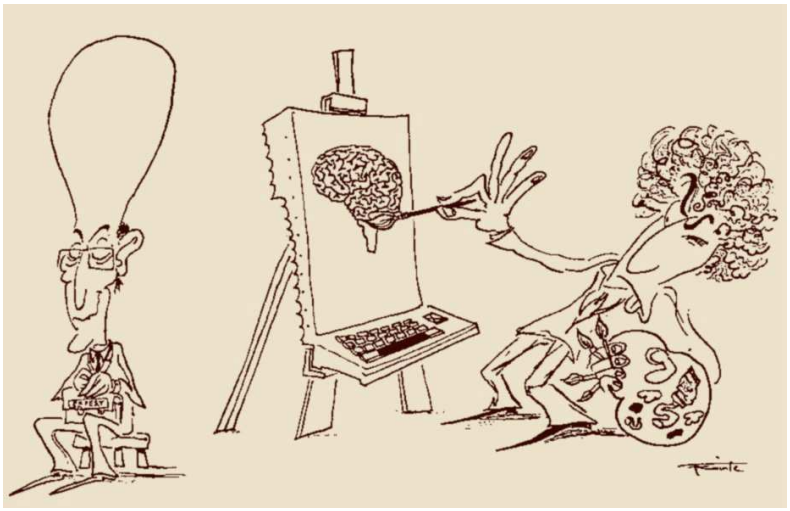


Figure 11 Caricature of the knowledge engineer

The caricature of the knowledge engineer extracting a supposedly already existing knowledge from the expert is definitely dead. Knowledge acquisition and modeling is a dialog and a joint construction work. We believe that the stakeholders (users, sleeping partners, managers, providers, administrators, customers...), should be more and more involved in the process of ontology engineering, and that instead of acquiring knowledge we should try to teach people how to do it by themselves, so that they can become independent. Training on ontology engineering will be as crucial for ontology maintenance as training in software engineering is for maintenance of software systems. This is also one of the reasons why semi-formal/natural language views (tables, lists) of the ontology must be available at any stage of the ontology life-cycle to enable interaction between and with the stakeholders.

Data collection is a goal-driven process. People in charge of the data collection always have an idea of what they are looking for and what they want to do with the collected data. It is essential to consider the end product that one desires right from the start (scenarios, models, ontologies…) and from that to derive what information should be identified and extracted during the data collection. The models will also provide facets, views or points of view that are useful to manage and modularize the collection products: organizational view, document view...

The process of data collection and its analysis usually comprises:

1. Preparation
2. Collection
3. Pre-analysis & informal modeling
4. Checks

   (These first steps have to be repeated until the completeness is judged sufficient - using scenarios, competency questions...)

5. Formalizing and validating

   (The whole process may have to be repeated if formalization or validation fails.)

When a data collection is based on human contact, it is important to remember that the central point of interest or discussion of someone is his/her role, activities and tasks. Therefore it is a very good subject to initiate the communication with.

Moreover it is vital to record or write down what is said word for word. The collection in itself must record the wording so that multiple and further analysis can be done on the original source. The vocabulary, the expressions, the phrasing, the mental representations descriptions must be collected intact. It is also interesting and usually productive to make people summarize or even analyze what they have said or written themselves. It may provide natural generalizations and specialization from the stakeholder to structure the collected data.

There is a great variety of interesting people and interesting material that can be considered during data collection. Let us consider the example of a scenario interested in supporting the integration of newcomers in an organization by providing them the right documents at the right time. The trivial stakeholders to be interviewed in this example are the newcomers themselves. The newcomer can be a young person joining the company as a first job, just graduated in finance, and who is going to work for the risk assessment department. The newcomer could also be a senior professional, with years of experience, recruited to become a technical project manager. To follow with the same scenario, it may also be interesting to consider people at different stages of their integration: just arrived, after one month, six months or even one year. Other types of stakeholders in this scenario could be people in charge of the integration process and the material needed, or training, and of course decision makers supervising the whole process. One should also consider people who are not directly concerned by the scenario or who are indirect stakeholders, but whose activity is closely related to some of the considerations included in the model. For example: specialists of task analysis and scheduling, of workflow, business analysts, quality managers, specialists in structuring and re-structuring the organization. They may provide overall views, methodologies, organization chart, flow charts, and other diagrams or document very relevant for our final model.

It is not only interesting to study what the problems are and to try to gather the requirements, it is also important in the inventory of fixtures to investigate the actual structures (e.g. training department, human resource department,…), people (teachers, mentors, …), their methodologies, their material, their mental representation… People may already have a solution in place and it must not be ignored. An example of investigation would be to observe the way a newcomer indexes and exploits the document he has been given and on the other hand to look at and compare with the way a mentor or someone in charge of providing these documents to newcomers indexes and uses them.

Finally, the profile and the role of the interviewed people have to be duly taken into account when preparing, managing and analyzing the data collection. Several methods and approaches may be used depending on the data source (may it be human or not). In the case of human contact the character itself of a person is to be taken into account. Someone very talkative, or with teaching or training skills may be handled differently (e.g. free expression) from someone shy or reserved who may need more entreaties (e.g. strongly structured interrogation).

3.4.2 Data collection techniques

This part gives a brief overview of some data collection techniques that could be envisaged for ontology engineering purposes.

3.4.2.1 Interviews

Interviews can be individual interviews or grouped interviews, they can take place with a large or small number of people, and they can be one-off interviews or 'repeater interviews'. Depending on these circumstances the techniques and the organization of the interviews can vary a lot. Principally an interview can be extremely structured (interrogation) or completely free (spontaneous expression) but the most common one is the semi-structured interview which can be anywhere on the continuum between these two extremes. A classic plan of progress during a semi-structured interview is:

1. Opening discussion: This first part is typically unstructured. To initiate the dialog first questions have to be very general, very broad. As we said before, a good subject to start with is the tasks and roles of the people interviewed. Then you must let people speak and tell stories until a long silence sets up. If needed this spontaneous expression can be kept running using the journalists' short questions (why? how? when? who? where? with what? any thing else?).
2. Flashback and clarification: Once you reach a terminal silence ("-anything else? … -Hum no!") you can switch to a more structured part. It implies you have been taking notes during the first part and you already built some informal personal representation so that you are able to identify points and subjects to be clarified or detailed through flashback questions. It is also in this part that you can use questions that have been prepared before according to the information that is looked for and that has not been spontaneously answered in the first part (e.g. strategic aspects detected in the scenarios).
3. Self-synthesis: Finally a good idea is to make interviewed people synthesize, summarize or analyze themselves what they said during the interview and make them conclude.

As in many case with acquisition techniques, the limits between the stages are not always rigid and iterations may occur. For instance, with someone very talkative a question of the flashback may trigger a new monologue and open discussion.

Some technologies can enable interviews (e.g. phone…) but human contact is usually the best option and it is also a good idea to run the interview at the interviewees' workplace.

3.4.2.2 Observations

As for interviews, observation comes with a broad range of options. It can be anywhere on the continuum between spying someone in his everyday activity without him knowing it (not very ethical but extremely pure view) and asking someone to simulate his activity in front of you in a reconstruction fashion (much more acceptable but it may skew or distort some real issues). The observation can be about people, the way they work (with or without making them comment), on a real task or on simulated scenario, in real time, recorded or based upon traces of the activity. It can also be focused on other indicators (documents manipulated, desk organization, acquaintance network…). Depending on the actor the interesting situation may be very different (a newcomer looking for information, a mentor explaining…).

3.4.2.3 Document Analysis

In [Aussenac-Gilles *et al.*, 2000] the authors explain that *documents or any natural language support (messages, text files, paper books, technical manuals, notes, protocol transcripts, etc.) are one of the possible forms the knowledge may take*. The French TIA (Terminology and Artificial Intelligence) group involves researchers from knowledge engineering, Terminology and Linguistics communities to develop methods and tools to assist extraction and modeling of knowledge from textual corpora. They *promote a new approach for knowledge modeling based on knowledge elicitation from technical documents. It benefits of the increasing amount of available electronic texts and of the maturity of natural language processing tools. The approach defines a framework where the knowledge engineer selects the appropriate tools, combines their use and interprets their results to build up a domain model* [Aussenac-Gilles *et al.*, 2000]. Their major statements are the following:

1. *to start from texts to acquire knowledge: texts are a tangible support, collecting stabilized knowledge which may be referred to in the model; unlike individual expertise, texts hardly contain very specific and practical know-how acquired through experience. Indeed, they are a consensual view on the domain. This might be an advantage, or a useful starter, especially for applications that address a large variety of users. However, it does not mean that texts will be the single knowledge source.*
2. *to connect source texts to conceptual models: relevant connections from concepts to the texts where they are defined or used to improve the model interpretation. Labels play a larger role that is hardly acknowledged. They help the reader to understand concept meanings in the domain (referential interpretation) and their representation in the model. Such connections also guarantee the model understanding and maintenance by keeping tracks of modeling choices.*
3. *to explore texts by applying natural language processing tools and techniques based on results in linguistics: these tools help systematic text analysis and make the modeling process easier. We do not promote here fully automated text interpretation. Current investigations tend to organize the application of such tools into efficient methods dedicated to specific application types.*

Figure 12 shows the modeling process from setting up a corpus for Natural Language Processing (NLP) tools to the design of a formal model:

1. *Setting up the corpus: From the requirements that explain the objectives underlying the model development, the designer selects texts among the available technical documentation. He must be an expert about texts in this domain to characterize their type and their content. The corpus has to cover the entire domain specified by the application. A glossary, if it exists, is useful to determine sub-domains and to verify that they are well covered. The corpus is then digitalized if it was not. Beginning the modeling may lead to reconsider the corpus.*
2. *Linguistic study: This step consists in selecting adequate linguistic tools and techniques and in applying them to the text. Their results are sifted and a first linguistic based elicitation is made. The objective is to allow the selection of the terms and lexical relations that will be modeled. The results of this stage are quite raw and will be further refined.*
3. *Normalization: This step includes two parts. The first part is still linguistic, it refines the previous lexical results. The second part concerns the semantic interpretation to structure concepts and semantic relations. The modeling goes from terminological analysis to conceptual analysis, that means from terms to concepts and from lexical relations to semantic ones. During normalization, the amount of data to be studied is gradually restricted.*
4. *Formalization: The formalization step includes building and validating the ontology. Some existing ontologies may help to build the highest levels and to structure it into large sub-domains. Then semantic concepts and relations are translated into formal concepts and roles and inserted in the ontology. This may imply to restructure the ontology or to define additional concepts, so that the inheritance constraints on the subsumption links are correct. Inserting a new concept triggers a local verification to*

guarantee the syntactic validity of the added description. A global validation of the formal model is performed once the ontology reaches a quite stable state to verify its consistency.

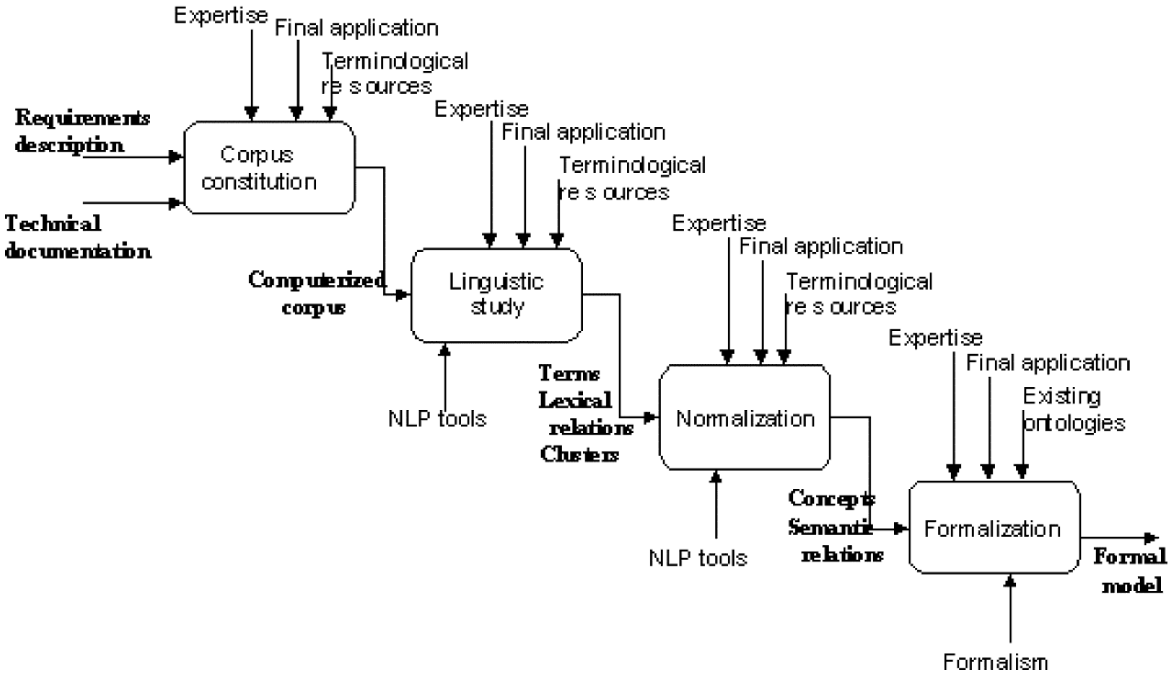


Figure 12 Steps of the modeling process from text according to TIA approach [Aussenac-Gilles *et al.*, 2000]

NLP tools are extremely interesting to scale up the process of data-collection because it can assist and partially relieve the knowledge engineer when large corpora have to be analyzed. However the document analysis aspect of data-collection is not limited to the linguistic content of documents. Graphical documents may be very rich too (organization charts, maps, tables, figures... see Figure 13). For these documents few assisting tools exists and large corpora of drawings, for instance, can not be analyzed by one person in charge of knowledge management.

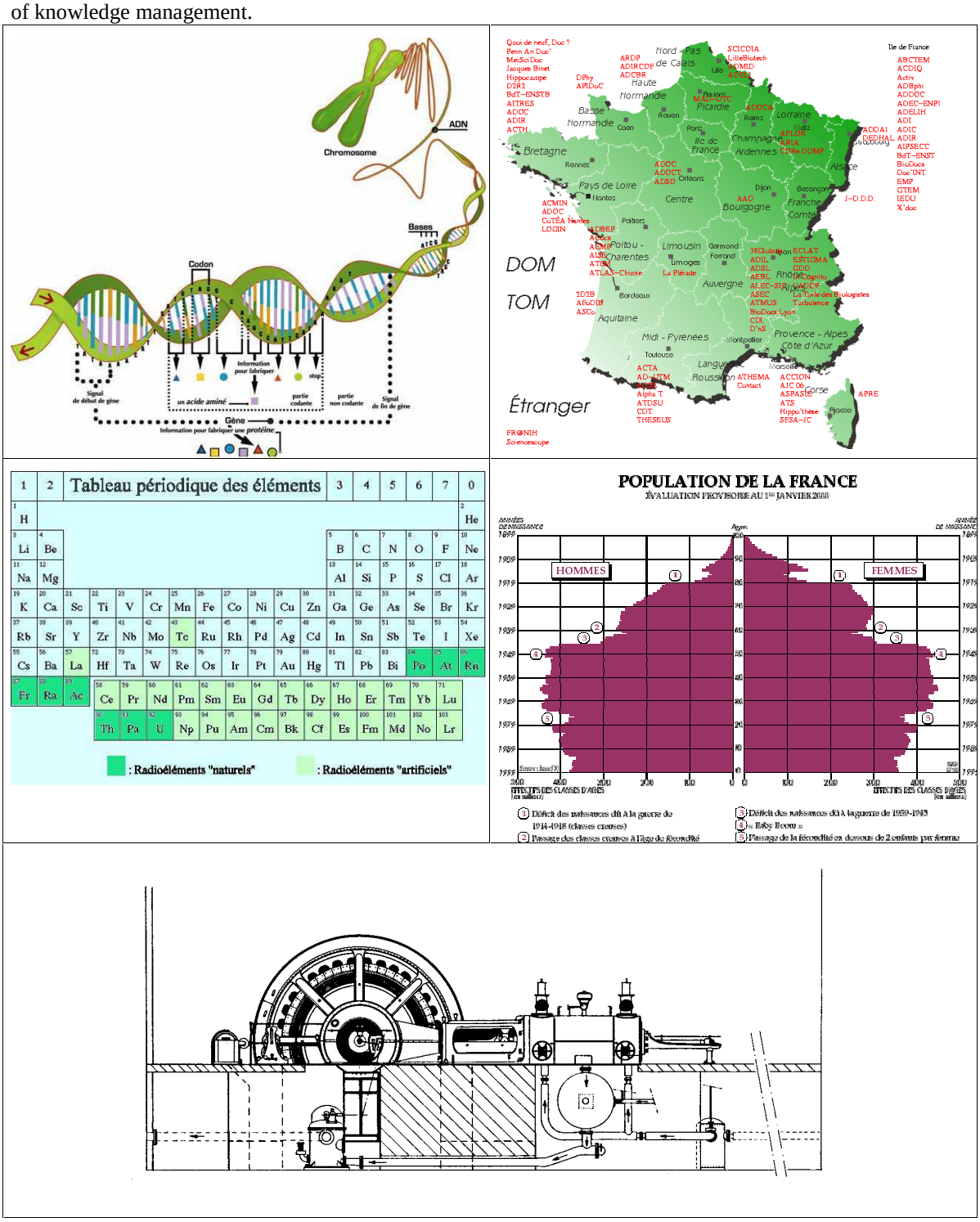


Figure 13 Examples of documents where knowledge can hardly be extracted automatically

Other aspect of documents are interesting such as the effective use of the document (e.g. compare an empty form with a filled form) or their flows in an organization (what are the typical pathways of a given type of document).

3.4.2.4 Questionnaire & Questioning

Questionnaires are a relatively inexpensive way of getting people to provide information. However, elaborating a questionnaire is a critical job and a good questionnaire has to be tested and reviewed several times to validate its usability just like any artifact. One of the first decisions to make is whether to use a questionnaire or some other method to collect the data. Note that in many situations, other data collection techniques may be superior.

From a general point of view, it may seem trivial but the questions must be formulated so that each respondent clearly understands the topic, the context and the perspective. The profile and the role of the respondents must be considered when choosing the question so that the persons are not asked to give information that they do not have. The order and the way questions are formulated may influence the answers, so one must be very careful not to skew the collection or to miss something.

In her paper [La France, 1992] Marianne La France identified six axioms concerning questioning which are in fact relevant for all the data collection techniques involving questions:

- *"Information is not extracted by questioning": Relevant information is not always established and ready to be transferred, it may be crafted and formulated "on-the-fly" in response to a question.*
- *"Questions require common ground": What is collected depends not only on the people questioned but also on the questioner, it is a sort of compromise.*
- *"All questions are leading questions": It is impossible to question someone without altering or influencing the people and their answers; even the order of the questions is influencing the results.* This remark can be compared to the 'probe effect' and is valid for nearly all techniques of data collection.
- *"Questions derive from knowledge rather than ignorance": Better questions are likely to come from people who are knowledgeable at least a minimum. However this must not be detrimental to the questioning, the collection must not turn into a debate between two experts.*
- *"Questions occasion the telling of stories rather than the furnishing of answers": Examples, scenarios are more likely to be the answer than abstract rules and theories. However it depends a lot on the people background and activity.*
- *"Good answers ring true rather than are true": At the end of the day the person in charge of data collection is the only judge of truthfulness and usefulness of collected data.*

3.4.2.5 Brainstorming & Discussions

It was originally a group problem-solving technique. More generally speaking, it consist of a meeting session based on spontaneous and unrestrained contributions from all members of the group. The discussion is centered on a specific theme, a set of ideas or problems with the purpose of generating new ideas or solving the problems.

It can be noticed that if both brainstorming and interviews have to be used, it is better to run the interviews before (at least the first wave) so that some ideas have already been gathered to sustain the discussion and that the exchange of ideas done during brainstorming will not bias the individual interviews.

In some cases, hierarchy or other background influence may bias a brainstorming session (e.g. someone may not want to publicly go against the opinion of his chief, someone may be too shy to speak). It is therefor extremely important to carefully choose participant. It is also a case where brainwriting can be used: people write down their ideas, put the paper in a basket and they are anonymously written down and discussed.

New technologies can enable other forms of discussions (e.g. news, mailing-lists…) but here again human contact is usually the best option.

3.4.3 Analysis and validation cycle

During data collection, several drafts and intermediate versions of data collection reports, structures and traces (ex: scenario reports, lexicons, interview transcriptions, pictures of observations...) will be generated. Analyzing each one of them will provide guidance and focus for further data collection. There may be several analysis of one version, for instance one may have to analyze a product again after discovering new areas of interest that had not been identified yet when the first analysis occurred. A product can also be analyzed by several people. For these reasons, it is important that the product be kept intact with the exact wording, phrasing and mental representations descriptions captured by data collection.

The analysis of a report resulting from a data collection session can be divided in several phases:

1. First the report has to be reviewed entirely without trying to structure or link together the information it contains. One must concentrate on identifying the blocks (e.g. a definition or a schema), the elements (e.g. a term denoting a concept) and the connectors (e.g. logical and chronological connectors). In fact, this first phase is about recognition.
2. Then the report is reviewed several times not only to make sure every interesting bit has been identified, but also and mainly to structure and bring out the links, relationships, dependencies, grouping and cross references. As a matter of fact, review will probably not be a linear reading.
3. Once it seems everything has been extracted, the analysis gives an informal but structured, annotated and tidy report of what has been collected.

It can be noted that it is extremely interesting here to work on electronic copies of the reports to facilitate manipulation and versioning.

Based on the analysis the following wave of data collection will probably be more focused trying to confirm or invalidate intermediary results and to gather further details. This can lead to more structured interviews, focused observation, discussions with the people about the intermediary results, or one-off communication (e.g. phone or e-mail) to clarify a special point. It can be noted that the advantage of e-mail is to directly provide an electronic copy of the answer with the exact wording and phrasing of the people. Once the informal models are stable enough they represent the starting point for formalization.

The validation process is not only the conclusion of the modeling process. To vouch for the quality and to enable the detection of problems as soon as possible in the model, it must be an ever-running background process of data collection an analysis. The validation can be done by:

- Confronting the models and observation.
- Confronting the models and the scenarios.
- Confronting the people reactions on the scenarios and the models.
- Confronting the people with the models.

3.5 Building an ontology from raw material

In this part, we explain the major phases we go through when building an ontology from scratch. The activities and guidelines given here are sometimes applicable to reuse and integration of ontologies and we will address that in a latter part. It is important to notice that from this stage of the ontology life cycle, literature on the subject acknowledges the importance of reaching and maintaining a commitment between stakeholders on the ontological work and the results.

Interestingly, [Bachimont, 2000] decomposes the ontology modeling process *in three stages, corresponding to three commitments. First, the semantic commitment specifying the linguistic meaning of concepts. Second, the ontological commitment specifying their formal meaning. Finally, the computational commitment specifying their effective computer-based use.*

3.5.1 Linguistic study & Semantic commitment

An ontology may take a variety of forms, but necessarily it will include a vocabulary of terms and some specifications of their meaning (i.e. definitions). [Uschold and Gruninger, 1996]

During scope definition and data collection, some terms and most probably some central terms will already have been identified. In [Uschold and Gruninger, 1996], for example, the authors reuse the competency questions to start their informal terminology: *Given the informal competency questions, we can extract the set of terms used in expressing the question; these will form the basis for the specification of the terminology. (…) In addition to identifying the set of terms, we must also produce informal definitions of the terms and address the problem of handling ambiguous terms. The informal dictionaries and glossaries defined using this methodology provide the intended semantics of the terminology and lay the foundations for the specification of axioms in the formal language.*

The terminological study is at the heart of ontology engineering, it produces the candidate terms for which consensual definitions have to be produced. In [Bachimont, 2000] we can find a theoretical justification of this compulsory step through linguistic study. The author explains the notion of semantic commitment necessary to define the primitives that will be contained in the ontology: *Notions are knowledge enabling to define other knowledge, but are also defined by this knowledge. The problem is that there does not exist general primitives in a domain but however it is necessary to have at our disposal primitives to undertake the knowledge modeling. (...) Therefore defining an ontology is not about characterizing or*

determining already existing primitives in a domain, but it is about modeling or designing primitives for the problem solving. How, do we design these primitives then? The idea is to start again from the linguistic expression of the knowledge of the domain.

As noticed in [Mizoguchi *et al.*, 1997] one of the key issues here *is 'de-contextualization' of the knowledge. Needless to say, every piece of knowledge is tuned to a context in which it is expected to apply. The first thing we have to do is to formalize the context and then, to establish a shared terminology.*

[Bachimont, 2000] calls this phase the semantic normalization: *The modeling work must be carried out from documents attested in the practice of a domain and gathered in a corpus.(...) The selection* [of the documents] *is based on criteria pertaining to the analysis method used (corpus analysis, for instance) and to the problem to be solved (to keep only the documents relevant for the problem to be solved). Setting up a corpus is delicate: the choice of a corpus introduces bias, that we may not be able to evaluate.* Here the definition of the scope and especially the scenarios are of valuable help to choose the corpus and the criteria for gathering and analysis.

Major part of the sources will be linguistic sources and the biggest part is text, so it is interesting to develop tools to analyze texts. As we saw in data-collection techniques, communities of terminology and artificial intelligence are very active in that domain. They develop tools based on statistics, linguistic rules, heuristics... to ease and semi-automate the process of text corpus analysis.

The corpus contains the expression of notions to be modeled. We are tempted to consider that the linguistic units used are concepts. In other words, we define concepts by their linguistic wording. (...) The advantage is that the concept receives straightaway the ability to be interpreted by specialists using it or consulting it. (...) The inconvenient is that, if these wordings are interpretable, nothing imposes that they must be interpreted the same way, or at least in a coherent and compatible way (...) Therefore it is necessary to constrain the spontaneous interpretation of the wordings made by specialists so that respecting these interpretation constraints, any specialist associate the same meaning than his colleagues to a wording (...) the wording cannot be used as a primitive since, by definition, a primitive must be defined in a non contextual way (...) the problem is to start again from the semantics of natural language to reach the non contextual definition of a wording. [Bachimont, 2000]

Bachimont's argumentation is based on the differential paradigm for characterizing the language semantics. *The differential paradigm is intralinguistic: it defines a linguistic unit from other linguistic units. The differences and similarities between units are defined in the language and can be described from a corpus attesting the usage and defining neighbor in context. The differential semantics determines the 'signified' of linguistic units in terms of differential features.* [Bachimont, 2000]

From a theoretical point of view, a differential feature is the extremity of an opposition or identity binary relation, called 'sememe'. Bachimont identifies several characteristics of the sememes:

- Generic sememes: they *attest the unit belonging to a class*.
- Specific sememes: they *determine differences enabling to distinguish linguistic units belonging to the same class*.
- Inherent sememes: they are *attributed by default to a term but possibly refuted by the context*.
- Afferent sememes: they are *attributed to the term by the context itself*.

We see that the same linguistic unit may not always have the same signified, depending on whether or not the context cancels the inherent sememes and activate the afferent sememes. [Bachimont, 2000]

Determining non contextual 'signified' is a semantic normalization: we fix, among possible meanings for a unit in context, the one that should always be associated. In fact, this amounts to choose a referential context in which, on principle, terms must be interpreted.

Semantic normalization is the choice of a reference context, corresponding to the task or the problem that motivated the elaboration of a formal knowledge representation. The point of view of the task enables the modeler to fix what must be the meaning of the considered linguistic unit. [Bachimont, 2000]

At this point, it is important to stress that, being a commitment, the normalization is a joint work between the knowledge engineer and the stakeholders.

In complement to these considerations, we give here the guidelines from [Uschold and Gruninger, 1996] that can be applied to the definition generation:

- *Produce a natural language text definition, being as precise a possible*
- *Ensure consistency with terms already in use; in particular:*
  - *Make ample use of dictionaries, thesauri and other technical glossaries,*
  - *Avoid introducing new terms where possible*
- *Indicate the relationship with other commonly used terms that are similar to the one being defined (e.g. synonyms or variants referring to the same underlying notion, but perhaps from different perspectives)*

- *Avoid circularity in defining terms*; this increases clarity in general and is essential for later formalization
- *The definition of each term is intended to be necessary and sufficient as far as this is possible in natural language. Provide clarification or additional information essential to understanding the definition as separate notes following the definition*

It is also noticed in several papers that one should give examples where appropriate, to clarify distinction or subtleties of definitions. Compared to definition in intension or in extension, examples can be defined as a representative sample of the extension: a good set of examples limited in size and covering as much as possible the differentia specializing the considered concept. For instance examples of 'fruits' should not be chosen only from the 'red fruits' or the example may badly bias the interpretation of the definition; following the same example the characteristics should be varied as much as possible: bananas, apples, grapes, lemons, coconuts and apricots are examples of fruits.

From definitions we build the concepts, but it rapidly emerges from terminological study that some terms have different roles. More precisely, some terms denote natural concepts and others denote relations between these concepts. The relations have their definition but equally important is the identification of the types of concepts they link.

As we said before, throughout the ontology design process, it is vital to reach and maintain an agreement with the scenario stakeholders. On reaching this agreement the authors of [Uschold and Gruninger, 1996] wrote: *There was considerable variation in the degree of effort required to agree on definitions and terms for underlying concepts. For some terms, consensus on the definition of a single concept was fairly easy. In other cases several terms seemed to correspond with one concept definition. In particular, there were several cases where commonly used terms had significantly different informal usage, but no useful different definitions could be agreed. This was recorded in notes against the definition. Finally, some highly ambiguous terms are identified as corresponding with several closely related, but different concepts. In this situation, the term itself gets in the way of a shared understanding.*

Thus, there exist three cases when studying terms:
- *One term corresponding to one and only one definition: This is the dream case, where there is no problem.*
- *Several terms corresponding to one definition: The terms are synonyms, one should keep the list of synonyms and choose one preferred term to refer to that definition.*
- *One term corresponding several concepts: This corresponds to an ambiguity.*

In [Uschold and Gruninger, 1996], ambiguous terms are handled the following way:

1. *Suspend use of the term; it is too ambiguous.*
2. *Clarify the ideas by carefully defining each concept using as few technical terms as possible, or only those whose meaning is agreed - consult the dictionary, thesauri, and/or other technical glossaries.*
3. *It can be helpful to give these definitions meaningless labels such as x_1, x_2, x_3 etc. so they can be conveniently referred to in a neutral way.*
4. *Determine which, if any, of the concepts are important enough to be in the ontology [usually one].*
5. *Choose a term for the concept, ideally avoiding the original ambiguous term (e.g. 'thing' rather than entity or object).*

Labeling concepts with one term is both convenient and dangerous. It is a major source of 'ambiguity relapse' where people happily relapse in ambiguity using the label terms according to the definition they associate with it and not the definition actually associated to it in the process of semantic commitment. As proposed above, an interesting exercise when ambiguity is lurking around is to replace labeling terms by meaningless identifiers, however it is obvious that it can only be used for modeling purposes and not for interfaces with the users. Presentation, re-presentation, views and interfaces are needed to bridge the gap between conceptual structures and user concerns.

3.5.2 Conceptualization and Ontological commitment

3.5.2.1 From terms to concepts

Once you have acquired enough knowledge you conceptualize it in a conceptual model that describes the problem and its solution [Fernandez *et al.*, 1997].

The lexicon is the bridge between a language and the knowledge expressed in that language. [Sowa, 2000]

During the terminological study, you will get aware that some terms and definitions are naturally close because they belong to the same theme or subject, the same interest area, the same domain, the same activity field... This grouping is to be encouraged and then actively performed. In [Uschold and Gruninger, 1996] the authors explain they *structure the terms loosely into work areas corresponding to naturally arising sub-groups. In their case, groups arose such that terms were more related to other terms within the same group than they were to terms in other groups.*

Their method is, for each term:

- *Provisionally categorize it for inclusion or exclusion, or note it as a borderline case*. This is determined mainly by reference to a previously agreed requirements document, especially scenarios and competency questions
- *Keep notes to record such decisions for future reference*
- *Group similar terms and potential synonyms together for further consideration*
- *Finally, identify semantic cross-references between the areas; i.e., concepts that are likely to refer to or to be referred to by concepts in other areas. This information can be used to help identify which work area to tackle first to minimize likelihood of rework.*

The authors use this partitioning of terms to partition the conceptualization work. They give the following advice: *address each work area in turn. Start with work areas that have the most semantic overlap with other work areas. These are the most important to get right in the first place, because mistakes lead to more re-work. If there is little overlap between work areas, work on them in any order*. [Uschold and Gruninger, 1996]

[Fernandez *et al.*, 1997] also starts from terms, but introduces a different approach for verbs and non verbs: For conceptualization, *you will structure the domain knowledge in a conceptual model that describes the problem and its solution in terms of the domain vocabulary identified in the ontology specification activity. The first thing to do is to build a complete Glossary of Terms (GT).(...) Once you have almost completed the GT, you must group terms as concepts and verbs. Each set of concepts/verbs would include concepts/verbs that are closely related to other concepts/verbs inside the same group as opposed to other groups. Indeed, for each set of related concepts and related verbs, a concepts classification tree and a verbs diagram is built. After they have been built, you can split your ontology development process into different, but related, teams.*

Concepts will be described using: Data Dictionary, which describes and gathers all the useful and potentially usable domain concepts, their meanings, attributes, instances, etc.; tables of instance attributes, which provide information about the attribute or about its values at the instance; tables of class attributes, to describe the concept itself, not its instances; tables of constants, used to specify information related to the domain of knowledge that always take the same value; tables of instances, which define instances; and attributes classification trees, to graphically display attributes and constants related in the inference sequence of the root attributes, as well as the sequence of formulas or rules to be executed to infer such attributes. [Fernandez *et al.*, 1997]

Verbs represent actions in the domain. They could be described using (...): a Verbs Dictionary, to express the meaning of verbs in a declarative way; tables of conditions, which specify a set of conditions to be satisfied before executing an action, or a set of conditions to be guaranteed after the execution of an action. Finally, to say that tables of formulas and tables of rules gather knowledge about formulas and rules. Note that both branches use these two intermediate representations. [Fernandez *et al.*, 1997]

[Gómez *et al.*, 1996] describes the conceptualization activities in detail and a special document (Intermediary Representation) is attached to each one of them:

- Data dictionary: *The data dictionary identifies and gathers all the useful and potentially usable domain concepts, their meanings, attributes, instances, etc.*
- Concepts classification trees: *The concepts classification trees organize domain concepts in taxonomies. They are used not only to know how concepts relate to each other, but to modularize the domain knowledge in independent ontologies.*

- Tables of instance attributes: *A table of an instance attribute provides information about the attribute or about its values at the instance level. For each instance attribute included at the field Instance Attribute of the data dictionary, a table must be created.*
- Tables of class attributes: *Class attributes describe the concept itself, not its instances. So, a table of a class attributes provides information about them and about their values. For each concept included at the field Class Attribute of the data dictionary, a table of class attributes must be created.*
- Table of constants: *Constants are used to specify information related to the domain of knowledge, they always take the same value, and they are usually used in formulas. For example, gravity acceleration is 9.8* .
- Tables of formulas: *In many domains, numerical values of instance attributes might be derived from numerical values of other attributes and constants by using formulas.*
- Attributes classification trees: *They display graphically attributes and constants that are related in the inference sequence of the root attributes, as well as the sequence of formulas to be executed to infer the root attributes.*
- Tables of instances: *If the ontology builder is sure that all the instances mentioned at the Instance field of the data dictionary exist in the domain, the next step is to create a table of instance for each instance identified in the data dictionary.*

To build the taxonomy of concepts, several approaches have been opposed in literature:
- Bottom-Up approach: Starting from the most specific concepts and building the structure by generalization; the ontology is built by determining first the low taxonomic level concepts and by generalizing them. This approach is prone to provide tailored and specific ontologies with fine detail grain concepts.
- Top-Down approach: Starting from the most generic concept and building a structure by specialization; the ontology is built by determining first the top concepts and by specializing them. This approach is prone to the reuse of ontologies and inclusion of high level philosophical considerations which can be very interesting for coherence maintenance.
- Middle-Out approach: Identifying central concepts in each area/domain identified; core concepts are identified and then generalized and specialized to complete the ontology. This approach is prone to encourage emergence of thematic fields and to enhance modularity and stability of the result.

The choice of an approach and its motivations are closely linked to the domain of intervention and the type of data manipulated. For example, [Uschold and Gruninger, 1996] argues that middle-out approach is the best approach: *The choice of whether to go top-down, middle-out or bottom-up has a number of effects (...). A bottom-up approach results in a very high level of detail. This, in turn 1) increases overall effort, 2) makes it difficult to spot commonality between related concepts and 3) increases risk of inconsistencies which leads in turn to 4) re-work and yet more effort. (...) A top-down approach results in better control of the level of detail, however starting at the top can result in choosing and imposing arbitrary high-level categories. Because these are not naturally arising, there is a risk of less stability in the model which in turn leads to re-work and greater effort. The emphasis on dividing up rather than putting together also results, for a different reason, in missing the commonality inherent in the complex web of inter-connected concepts. (...) A middle-out approach, by contrast, strikes a balance in terms of the level detail. Detail arises only as necessary, by specializing the basic concepts, so some effort is avoided. By starting with the most important concepts first, and defining higher level concepts in terms of these, the higher level categories naturally arise and thus are more likely to be stable. This, in turn, leads to less re-work and less overall effort.* Middle-out approach is linked to the idea of identifying relevant thematic groups of terms. However, as noticed by the authors themselves, the notion of basic concept can be tightly dependent on the application context. *For example, 'dog' is basic, 'mammal' is a generalization, and 'cocker spaniel' is a specialization. While differences arise for individuals of widely varying expertise in an area, (e.g. a dog breeder may regard a particular species as basic), broadly, what is basic is the same for most people.* [Uschold and Gruninger, 1996]

3.5.2.2 Taxonomic skeleton of the ontology

As we have seen with the set of intermediary representations proposed above, ontology usually includes a taxonomy of concepts. *One of the principal roles of taxonomies is to impart structure on an ontology, to facilitate human understanding, and to enable integration.* [Guarino and Welty, 2000].

As stated in the definitions, a taxonomy is a classification based on similarities. It is not surprising to find this structure at the heart of knowledge modeling since it is the counterpart of two of the most elementary inferences we use everyday almost as a reflex:
- classification or identification: the inference whereby we determine if something belongs to a class or a category e.g. if you see a horse, if you recognize it as a horse, it means you have been able to classify/identify the object we were seeing as belonging to the class/category of concepts labeled "horse".

- categorization: the inference whereby we identify and organize categories/classes of things in our world. If you have green peas, green beans, tomatoes and strawberries on a table and you are asked to divide them into two categories based on one criteria, you will most probably and quite easily create a "green things" category and a "red things" category.

The relation at the heart of the taxonomy is the subsumption: a concept C_1 subsumes another concept C_2 if and only if all instances of C_2 are necessarily instances of C_1. To subsume is to incorporate a concept under a more general one. Based on the subsumption link, is defined the inheritance mechanism, whereby a concept inherits from the characteristics of a concept that subsumes it. The nature of the structure is still a debate, especially between people believing in a pure tree structure, people in favor of a lattice structure, or people in favor of a general multi inheritance graph. We will present here seminal contributions to the rationalization of the global structuring of the taxonomy.

Following the linguistic study presented in the previous part, [Bachimont, 2000] argues that the global structuring of the ontology is a tree.

The differential semantics enables to describe units between themselves by the similarities which unite them and the differences that distinguish them. Now, described units have in common the ability to be comparable: they have in common the characteristic that 'they say or they are something' so that in a second stage we can determine that they are not the same thing. Therefore, each unit determines itself from one ultimate generic unit, a root unit, to which it belongs. For instance a common root for ontologies is the "Thing" concept.

Moreover, all units determine themselves on the one hand from the generic unit they belong to, on the other hand from the differences that distinguish them. This means that the networks of units is a property inheritance network where children units inherit sememes from a generic parent unit.

Therefore, the problem is to determine the structure of such an inheritance network. (...) Suppose that a unit U has several direct parent units, let's say two. These two parent units are distinct, they determine themselves from similarities and differences between themselves. If they are characterized only by similarities between themselves, it implies that one is generic compared to the other, and therefore only the other one is a direct parent. Therefore they must be characterized by some differences that distinguish them. This implies that they determine themselves from mutually incompatible features (...) Therefore a given unit can only have one and only one parent unit. So the network must be a tree. [Bachimont, 2000]

As recalled in [Kassel *et al.*, 2000] an ontology uses the philosophical distinction between the intension and the extension of a concept. *The intension corresponds to the meaning of the concept, or to the notion, it is a set of properties verified by the objects targeted by the concepts (the extension of the concept) whatever the situation of the world is. The latter constraint characterizes essential properties by opposition to incidental properties that are valid only for specific situations.* The basis structural principle of the differential definition of intensions, or notions says that the defined notion is situated in relation to a genus according to a differentia. The notions of genus and differentia go back to Aristotle[Sowa, 2000b] who defined species by giving its genus (genos) and its differentia (diaphora). The genus is the kind under which the species falls. The differentia is what characterizes the species within that genus. Applying this principle, [Kassel *et al.*, 2000] gives the example of a the definition of a 'message' based on the genus 'document': "*a message is a document addressed by a sender to an addressee*"; the differentia is characterized here by the type of role played by the document in communication.

[Bachimont, 2000] proposes to determine the meaning of a unit in the tree, a node, using four fundamental principles: the *differential principles that, according to the neighbors of a node, impose on us to make explicit similarities and differences. These principles are:*

- *The parent community principle: any unit is determined by the similarities it has in common with its parent. We must make explicit its similarities to the parent unit. It is, mutatis mutandis, the Aristotelian principle of definition by close kind.* This principle is at the core of the generalization process.
- *The parent difference principle: any unit is different from its parent, otherwise there would be no point to define it. We must make explicit the difference that distinguishes it from its parent unit. It is, mutatis mutandis, the Aristotelian principle of definition by specific difference.* This principle is at the core of the specialization process.
- *The brother difference principle: any unit is different from its brothers, otherwise there would be no point to define it. We must make explicit the difference that distinguishes it from its brother units. This principle is not Aristotelian but it comes from the differential paradigm.* The differences are the specificities of the differentia for the different brothers.
- *The brother community principle: by definition all the children units of a parent unit have in common the same generic feature as the one they share with their parent unit. But we must establish another community between children units: the one that enables us to define the differences mutually exclusive between children units.*

Bachimont gives the example of a function of person in a movie: three concept can be organized according to the previous definitions: Function, Actor, Director

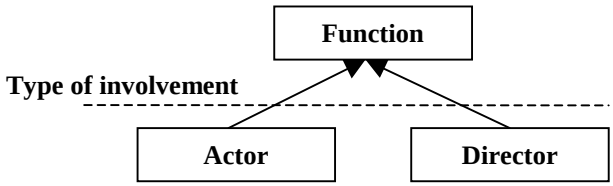


Figure 14 Example of Bachimont's principles

These principles are:

- The parent community principle: Actor and Director **are Functions**.
- The parent difference principle: Actor and Director **are restrictions of Function** for a person involved a movie.
- The brother difference principle: an Actor **plays** in the film a Director **makes** the film.
- The brother community principle: **Both** Actor and Director **are Functions of a person in a film**.

By considering the definitions we can bring out similarities between the differentia. (...) These groupings correspond to the notion of semantic axis [Kassel *et al.*, 2000]. A semantic axis groups the children of a concept according to the characteristics involved in the definition of their differentia. This notion reifies the bother community and difference principles. For instance: documents distinguished by their medium (paper, digital...), documents distinguished by their role (message, reference...), document distinguished by their status (official, informal,...) and so on. *Formally speaking, an axis corresponds to a binary relation A(x,y) which projections, with different values of the second argument (...), define as many unary properties playing the role of differentia for notions.*

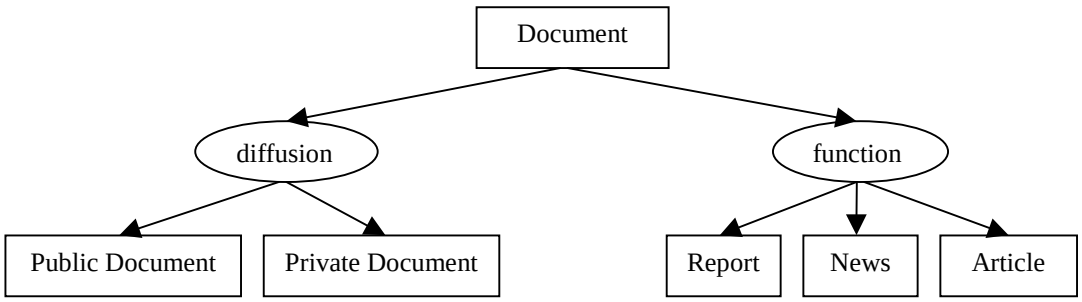


Figure 15 Example of [Kassel et al., 2000].

These semantic axis introduce points of views in the inheritance hierarchy. They do not oblige the designer to chose one and only one criteria of differentia below a genus. This is close to facets in object-oriented modeling languages where different taxonomies are built, 'footbridges' are sets to indicate equivalence between two concepts of two different taxonomies.

[Bachimont, 2000] concludes and summarizes his opinion on semantic commitment and modeling primitives as follows: *The differential principles associated to a node of the ontological tree make explicit in linguistic domain terms what must be understood from the wording of the node. (...) Therefore it is by respecting these principles that we can ensure that the wording is not merely a linguistic unit with a meaning varying with its use context, but a primitive with an invariable meaning. (...) the differential principles refine and adjust the meaning that users spontaneously attribute to the nodes of the ontological tree (...) We obtain a network in which the position of a node determines its meaning. The meaning defined by the position in the tree is independent from the context. The wording can then be used as a primitive. By respecting differential principles, by committing to their semantics, the nodes of the ontological tree correspond to concepts that can be used as modeling and formalizing primitives. We have just defined the semantic commitment on which is based the ontology: set of interpretative prescriptions that must be respected for a wording to operate as a primitive.*

[Bachimont, 2000] insists on the fact that this commitment is limited in its scope, *semantic normalizing builds one meaning by favoring a special context, the one of the considered task. The semantic commitment brings out an ontology only locally valid, regionally valid in the framework of a domain and a task.*

Guarino also made a significant contribution to the theoretical foundations of the field. In 1992 he started by distinguishing natural concept, role, attributes, slots, qualities. He proposed *to use the term 'role' only in Sowa's sense; bearing on Husserl's theory of foundation*, he distinguishes *between roles and natural concepts, and* defines *a role as a concept which implies some particular 'pattern of relationships', but does not necessarily act as a conceptual component of something.* He defines *'attribute' as concepts having an associate relational interpretation, allowing them to act as conceptual components as well as concepts on their own;* He proposes *a formal semantics which binds these concepts to their corresponding relations, and a linguistic criterion to distinguish attributes from 'slots', i.e. from those relations which cannot be considered as conceptual components. Moreover,* he shows *how the choice of considering attributes as concepts enforces 'discipline' in conceptual analysis as well as 'uniformity' in knowledge representation.* [Guarino, 1992]

This first work led him to the following definitions, where the nec operator is defined as *the modal necessity (box) operator*, ≤ is the part of relation and /≤ is its negation.

Definition: *The concept α is founded on β (written $\alpha \Downarrow \beta$) if:* $\mathbf{nec}\ \forall x\ (x \in \alpha \supset \exists y\ (y \in \beta \wedge x\ /\leq y \wedge y\ /\leq x))$.

Definition: *α is called founded (written $\alpha \Downarrow$) if there exists a β such that $\alpha \Downarrow \beta$. α is called essentially independent (written $I(\alpha)$) if $\neg (\alpha \Downarrow)$, and self-founding if $\alpha \Downarrow \alpha$.*

Definition: *A concept α is called semantically rigid (written $R(\alpha)$) if* $\forall x\ (x \in \alpha \supset \mathbf{nec}\ (x \in \alpha))$.

Definition: *A concept α is called a role if it is founded but not semantically rigid, that is, $\alpha \Downarrow \wedge \neg R(\alpha)$.*

Definition: *A concept α is called a natural concept if it is essentially independent and semantically rigid, that is, $I(\alpha) \wedge R(\alpha)$.*

In [Guarino and Welty, 2000] is presented an additional and exemplified comprehensive set of definitions aiming at providing the ontologists with methodological elements. The first notion presented is the notion of identity: *Strictly speaking, identity is related to the problem of distinguishing a specific instance of a certain class from other instances by means of a characteristic property, which is unique for it (that whole instance).*

To explain identity, [Guarino and Welty, 2000] defines the notion of rigid property. A rigid property is *a property that necessarily holds for all its instances*. Guarino introduces the following notations:

Rigid	ϕ^{+R}	*ϕ is a necessary property for all its instances*
Non-Rigid	ϕ^{-R}	*ϕ is not a necessary property for all its instances*
Anti-Rigid	$\phi^{\sim R}$	*ϕ is an optional property for all its instances*

Anti-rigidity attempts to capture the intuition that all instances of certain properties must possibly not be instances of that property.

Authors give the example of a Person which is rigid since an instance x of Person cannot cease to be a Person unless the instance cease to be. Student is anti-rigid since all the instances of Student have the ability to cease to be a Student.

An identity condition (IC) for a arbitrary property ϕ is usually defined as a suitable relation ρ satisfying the following formula: $\phi(x) \wedge \phi(y) \rightarrow (\rho(x,y) \leftrightarrow x = y)$.

The first problem is related to the need of distinguishing between supplying an IC and simply carrying an IC: it seems that non-rigid properties (...) can only carry their ICs, inheriting those supplied by their subsuming rigid properties.

Definition: *Let ϕ be a rigid property, and $\Gamma(x,y,t,t')$ a formula containing x, y, t, t' as the only free variables, such that $\neg \forall xytt'(\Gamma(x,y,t,t') \leftrightarrow x = y)$. We say that ϕ carries the IC Γ iff one of the two following definitions is verified.*

Definition: *Γ is a necessary IC carried by ϕ when*

$$E(x,t) \wedge \phi(x,t) \wedge E(y,t') \wedge \phi(y,t') \wedge x=y \rightarrow \Gamma(x,y,t,t')$$

$$\neg \forall xy(E(x,t) \wedge \phi(x,t) \wedge E(y,t') \wedge \phi(y,t') \rightarrow \Gamma(x,y,t,t'))$$

Definition: *Γ is a sufficient IC carried by ϕ when*

$$E(x,t) \wedge \phi(x,t) \wedge E(y,t') \wedge \phi(y,t') \wedge \Gamma(x,y,t,t') \rightarrow x=y$$

$$\exists xytt'\ \Gamma(x,y,t,t')$$

Remark: *ICs are 'inherited' along a hierarchy of properties.*

Definition: *A non-rigid property carries an IC Γ iff it is subsumed by a rigid property carrying Γ.*

Definition: *Any property carrying an IC is marked with the metaproperty +I (-I otherwise).*

Definition: *A property ϕ supplies an IC Γ iff i) it is rigid; ii) it carries Γ; and iii) Γ is not carried by all the properties subsuming ϕ. This means that, if ϕ inherits different (but compatible) ICs from multiple properties, it still counts as supplying an IC.*

Definition: *Any property supplying an IC is marked with the metaproperty +O (-O otherwise). The letter "O" is a mnemonic for "own identity".*

Remark: *From the above definitions, it is obvious that +O implies +I and +R. (...)*

Definition: *Any property carrying an IC (+I) is called a sortal.*

We can summarize the notation as follows:

Carrying an IC	ϕ^{+I}	ϕ carries an identity condition
Not carrying an IC	ϕ^{-I}	ϕ does not carries an identity condition
Supplying an IC	ϕ^{+O}	ϕ supplies an identity condition
Not supplying an IC	ϕ^{-O}	ϕ does not supply an identity condition

The second important notion discussed in [Guarino and Welty, 2000] is Unity which *is related to the problem of distinguishing the parts of an instance from the rest of the world by means of a unifying relation that binds them together (not involving anything else).*

Definition: *Let ω be an equivalence relation. At a given time t, an object x is a contingent whole under ω if $\forall y(P(y,x,t) \rightarrow \forall z(P(z,x,t) \leftrightarrow \omega(z, y,t)))$*

Definition: *Let ω be an equivalence relation. An object x is an intrinsic whole under ω if, at any time where x exists, it is a contingent whole under ω.*

Remark: *If an object is always atomic (i.e., it has no proper parts), then it is an intrinsic whole under the identity relation.*

Definition: *A property ϕ carries a unity condition (+U) iff there exists an equivalence relation ω such that all its instances are intrinsic wholes under ω.*

As an example, authors *distinguish three main kinds of unity for concrete entities (i.e., those having a spatio-temporal location):*

- *Topological unity: based on some kind of topological connection (a piece of coal, a lump of coal)*
- *Morphological unity: based on shape (a ball, a constellation)*
- *Functional unity (a hammer, a bikini)*

As the examples show, nothing prevents a whole from having parts that are themselves wholes (with a different UC).

As with rigidity, in some situations it maybe important to distinguish properties that do not carry a common UC for all its instances, from properties all of whose instances are not intrinsic wholes. (...)

Definition: *A property has anti-unity (~U) if every instance of the property is not an intrinsic whole. Of course, ~U implies -U.*

We can summarize the notation as follows:

Carrying an UC	ϕ^{+U}	ϕ carries an unity condition
Not carrying an UC	ϕ^{-U}	ϕ does not carries an unity condition
Carrying an anti-UC	$\phi^{\sim U}$	ϕ carries an anti unity condition

Finally, [Guarino and Welty, 2000] defines the notion of External dependence: *a property ϕ is externally dependent on a property ψ if, for all its instances x, necessarily some instance y of ψ must exist, which is not a part nor a constituent of x. (...) x is existentially dependent on y,* if, *x cannot actually exist without y actually existing. (...) A property which is externally dependent on some other property will be marked with the meta-property +D.*

Authors give the example, of *PARENT being externally dependent on CHILD (one can not be a parent without having a child), but PERSON is not externally dependent on heart nor on body (because any person has a heart as a part and is constituted of a body).*

The extensive work of Guarino contributes to clean-up the theoretical foundations of ontology engineering. Where things becomes even more useful is that based on these definition [Guarino and Welty, 2000] identifies constraints to be verified by the taxonomy so that an ontologist relying on these definitions can check some validity aspects of his subsumption links:

Rigidity constraints: $\phi^{\sim R}$ *can't subsume* ψ^{+R}

Identity constraints: ϕ^{+I} *can't subsume* ψ^{-I} *and properties with incompatible ICs are disjoint.*

Unity constraints: ϕ^{+U} *can't subsume* ψ^{-U} *and* $\phi^{\sim U}$ *can't subsume* ψ^{+U}

Dependence constraints: ϕ^{+D} *can't subsume* ψ^{-D}

The only problem so far is that no tool is available to help an ontologist do that work independently from a formalism, and it can become titanic to apply this theory to large ontologies. IODE from OntologyWorks [Guarino and Welty, 2002] is an interesting integrated tool that is currently being used in several projects.

To assists the structuring, semi-automatic methods are of great interest. An example is found in [Sowa, 2000b] on Formal Concept Analysis for minimal lattices generation by Michael Erdmann, Bernhard Ganter and Rudolf Wille. Boolean attributes are used as differentiae, in an example is about beverages:

	Attributes				
Concept Types	**nonalcoholic**	**hot**	**alcoholic**	**caffeinic**	**sparkling**
HerbTea	x	x			
Coffee	x	x		x	
MineralWater	x				x
Wine			x		
Beer			x		x
Cola	x			x	x
Champagne			x		x

Table 1 Boolean attributes of beverage concepts

Starting from this table, the algorithm builds the following lattice:

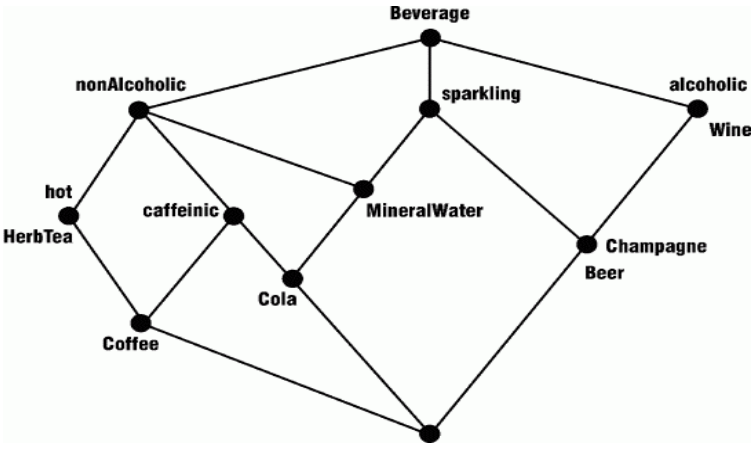


Figure 16 Minimal lattice of beverage concepts

The algorithm being incremental and iterative the addition of two new attributes to distinguish Champagne from Beer can be made afterward : Made From Grape and Made from grain. Introducing these differences for Beer and Champagne, the algorithm generates a new lattice.

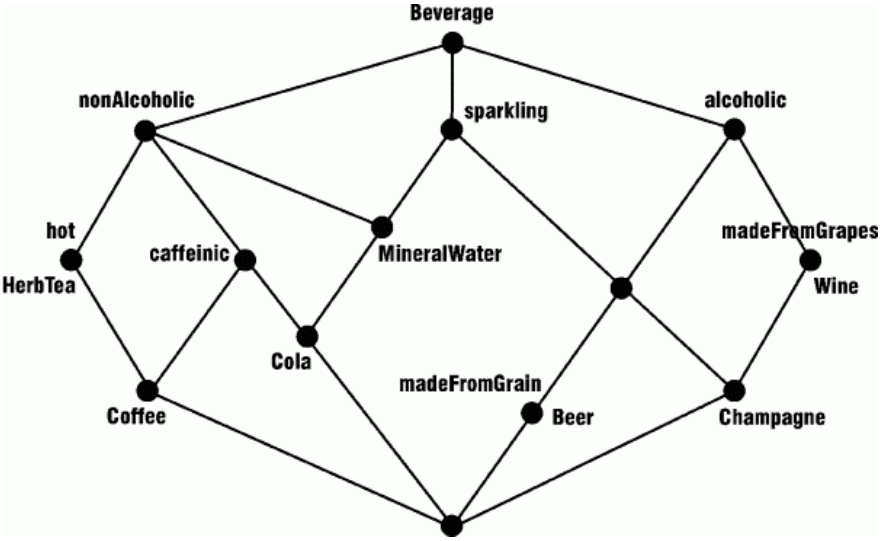


Figure 17 Revised lattice of beverage concepts

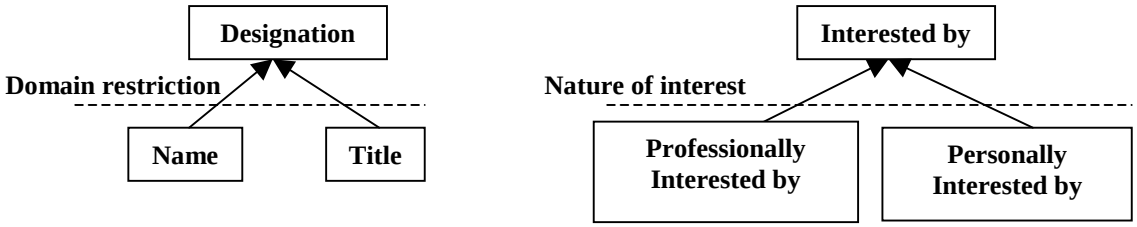
Yet it still takes a human (more precisely a drinker ;)) to see that the Coffee should be declared as made from grain too.

In addition to terms corresponding to concepts, the ontologist also gathers terms corresponding to relations. [Bachimont, 2000] declares that *relations must also be defined in the ontology. However they cannot be defined just like the concepts, because, since they link concepts together, their definition must be based on them. If we only consider binary relations, relations can be defined in the following way:*

1. *A relation is defined by the concepts it links up (...); these concepts constitute the semantic signature of a relation.*
2. *Besides it is defined by the intrinsic semantic content, on which the two concepts are centered around (...). The intrinsic semantics of the relation is specified by comparison to other relations having the same semantic signature according to the differential paradigm (...). The similarity is not reduced to the fact of having the same signature: for example, the relations 'voluntary agent' and 'involuntary agent' besides to have in common their signature, also have in common the parent relation 'agent'.*

In other words, each semantic signature is potentially the root of a differential tree of relations having the same signature and specified according to the differential principle. The semantic signatures also constitute a tree: therefore we have a relation tree in addition to the concept tree.

We can give the two following examples:



First case the signature is specialized, second case the signature is untouched but the intension is specialized.

[Staab and Maedche, 2000] claims that the semantics of ontology definitions is mostly void without the specification of axioms, and that *axioms are objects, too. While support for modeling of concepts and relations has been extensively provided through convenient graphical user interfaces, the same cannot be said about the modeling of axioms. Often axiom specification in ontology modeling environments is restricted to what subsumption offers in a description logics framework (...) or to what the ontology engineer encodes in some kind of first-order logic language (...), or axiom modeling is neglected at all (...) This situation is*

detrimental to the modeling of large-scale ontologies, because it aggravates engineering and maintenance of large sets of axioms.

The core idea is to use a categorization and an object representation of axioms that organize axioms and that provide a compact, intuitively accessible representation.

They *reach these objectives through a methodology that classifies axioms into axiom types according to their semantic meaning. Each type receives an object representation that abstracts from particular syntax (as far as possible) and keeps only references to concepts and relations necessary to distinguish one particular axiom of one type from another one of the same type.*

In their article the authors propose and explore the following categorization of axioms:

1. *Axioms for a relational algebra*
   (a) Reflexivity of relations
   (b) Irreflexivity of relations
   (c) Symmetry of relations
   (d) Asymmetry of relations
   (e) Anti-symmetry of relations
   (f) Transitivity of relations
   (g) Inverse relations
2. *Composition of relations (e.g. GreatFather = Father o Father)*
3. *(Exhaustive) Partitions (e.g. Mammal and Fish share no instances)*
4. *Axioms for sub-relation relationships*
5. *Axioms for part-whole reasoning*
6. *Non monotonicity*
7. *Axioms for temporal and modal contexts*

Authors of [Maedche and Staab, 00] note that *non-taxonomic relations between concepts appear as a major building block in common ontology definitions.* They describe *an approach for discovering non-taxonomic conceptual relations from text and, hence, for facilitating this (...) part of ontology engineering. Building on the taxonomic part of the ontology,* their *approach analyzes domain-specific texts. It uses shallow text processing methods to identify linguistically related pairs of words. An algorithm for discovering generalized association rules analyzes statistical information about the linguistic output. Thereby, it uses the background knowledge from the taxonomy in order to propose relations at the appropriate level of abstraction. (...) The discovery algorithm determines support and confidence measures for the relation-ships between these three pairs, as well as for relationships at higher levels of abstraction.* They present their result and an evaluation showing that even if their *approach is too weak for fully automatic discovery of non-taxonomic conceptual relations, it is highly adequate to help the ontology engineer with modeling the ontology through proposing conceptual relations.*

3.6 Formalization and operationalization of an ontology

3.6.1 On a continuum between Informal and Formal ontology

[Uschold and Gruninger, 1996] explains that the *degree of formality by which the vocabulary of an ontology is specified varies from informal definitions expressed in natural language to definitions stated in a formal language such as first-order logic with a rigorously defined syntax and semantics. Similarly, (...) the uses of ontologies ranged from informal requirements such as a glossary for shared understanding among users to more formal requirements such as interoperability among software tools.*

Therefore *the formality required from the language for the ontology is to a large extent dependent on the degree of automation in the various tasks which the ontology is supporting. If an ontology is a framework for communication among people, then the representation of the ontology can be informal, as long as it is precise and captures everyone's intuitions. However, if the ontology is to be used by software tools or intelligent agents, then the semantics of the ontology must be made much more precise.* The degree of formalization depends on the operationalization needs.

[Uschold and Gruninger, 1996] even proposed *four somewhat arbitrary points along what might be thought of as a continuum:*

- *highly informal: expressed loosely in natural language*
- *semi-informal: expressed in a restricted and structured form of natural language, greatly increasing clarity by reducing ambiguity*
- *semi-formal: expressed in an artificial formally defined language*
- *rigorously formal: meticulously defined terms with formal semantics, theorems and proofs of such properties as soundness and completeness*

So the final formal degree of the ontology depends on the use intended and it starts from highly informal except, as we will see when integrating already existing formal ontologies. It is important to recognize that the formalization task does not consist of replacing an informal version by a formal one but to augment an informal version with the relevant formal aspect needed by the operational system. The purpose is not to take an informal ontology and translate it in a rigorously formal ontology, the purpose is to develop the formal counterpart of interesting and relevant semantic aspect of the informal ontology in order to obtain a documented (informal description possibly augmented by navigation capabilities from the formal description) operational ontology (formal description of the relevant semantic attributes needed for the envisioned system). The ontologist must stop his progression on the continuum between informal and formal ontology as soon as he has reached the formal level necessary and sufficient for his system.

The informal version of the ontology is not merely an intermediary step that will disappear after formalization, the formal form of ontology must include the natural language definitions, comments, remarks, that will be exploited by humans trying to appropriate the ontology. The informal natural language version is important because as stressed by [Mizoguchi and Ikeda, 1997] *ontologies have to be intelligible both to computers and humans.* This plays an important role for documenting the ontology and as we shall see later it is for instance very good for ontology reuse, reengineering and reverse-engineering. Formal languages and logics may be vital for computational implementation, yet the natural language and the terms remain the natural means of access for humans.

This point is also corroborated in [Uschold and Gruninger, 1996] talking about the wording used: *Although the text version of the ontology served as the specification for producing code, there was a requirement that it be accessible to non-technical readers. To achieve an appropriate balance between technical precision and clarity, we:*

1. *kept the text definitions relatively informal,*
2. *equivalent, but more technically precise definitions cast using the primitives in the meta-ontology are used in documentation directly accompanying the code.*

An ontology should effectively communicate the intended distinctions to humans who design agents. This means that ambiguity should be minimized, distinctions should be motivated, and examples should be given to help the reader understand definitions that lack necessary and sufficient conditions. When a definition can be specified in formal axioms, it should be. In all cases, definitions should be documented with natural language and examples to help clarify the intent.

Another interesting point about the process of formalizing is found in [Bachimont, 2000] who asserts that the formalization of knowledge leads to a second commitment: the ontological commitment. *The ontological tree and the semantic commitment that it makes explicit provide primitives. (...) It is then possible to define a formal semantics for concepts. (...) We will call 'semantic concept' the concepts before semantic commitment and 'formal concepts' the concepts respecting the semantic commitment. Every concept has a formal semantic that links it to a set of referents (...), as soon as we adopt a formal semantics we no longer consider notions but object extensions. (...)*

Bachimont then asks: *what is the structure that links these formal concepts together?*

- *First, formal concepts verify the similarity relations linking the semantic concepts. (...) Similarity corresponds to the fact that a notion is included in another (...) therefore the extension of the included notion is included in the extension of the including notion.*
- *Secondly, the difference between semantic concepts, where two notions are mutually exclusive, do not have direct repercussions on the formal concepts (...),as soon as we adopt a formal semantics we no longer consider notions but extensions of objects. (...) The fact that notions are exclusive implies that extensions are different. But it does not imply that extensions are disjoint. (...) This means that among the relations between formal concepts we still have inheritance relations, but we no longer have exclusion. The structure of formal concepts is no longer necessarily a tree, but more generally a lattice.*

Finally from the operationalization point of view, [Bachimont, 2000] explains that *formalizing knowledge is not sufficient, we must then use it in an operational system. But a system does not use concepts according to their semantic interpretation, which is only within the reach of a language speaker (that is to say, until further notice, humans) (...) A system can only exploit a concept according to the operations or rules that it can associate with it. Therefore the semantic allowing a system to use a concept is the computer specification of the operations applicable to a concept. (...) We shall call this semantics* ***computational semantics*** *(...) by adding a computational semantics to the concepts of the ontology, we define a computational ontology.* Inferences and computational semantics are currently mainly buried in the code of software. Their intension and intention are not captured yet they play a vital role in the choices of conceptualization.

An important point too, is that one must make the difference between a formalization needed for ontology engineering purposes (e.g. in the case of Guarino the additional formalization is used for coherence checking) and a formalization needed for operationalization *i.e.* for which the formal aspect will be exploited at run-time.

3.6.2 Meta-ontology

As we said, if your ontology is to be exploited by a computer, you will have to make it computable. *To make your ontology computable, you need to implement it in a formal language.* [Fernandez *et al.*, 1997]

[Uschold and Gruninger, 1996] explains that coding the conceptualization captured in the previous stage in some formal language involves:

1. *Committing to the basic terms that will be used to specify the ontology (class, entity, relation); this is often called the 'meta-ontology' because it is in essence, the* [underlying] *ontology of representational terms that will be used to express the main ontology*
2. *Choosing a representation language (which is capable of supporting the meta-ontology)*
3. *Writing the code.*

The authors also underline the necessity of minimizing the encoding bias: *The conceptualization should be specified at the knowledge level without depending on a particular symbol-level encoding. The encoding bias of an axiomatisation, that is, representation choices that are made purely for the convenience of notation or implementation, should be minimized. The goal is to enable knowledge sharing across agents that may be implemented in different representation systems and styles of representation.* The important advice here is *to not commit to any particular meta-ontology. Doing so may constrain thinking and potentially lead to inadequate or incomplete definitions. (…)* [Uschold and Gruninger, 1996] Even if the considerations of the formalization should not pollute the conceptualization step, it looks like people conceptualizing are biased by there background and may be thinking in terms of classes and inheritance much too early in the conceptualization. It is a very hard task to make abstraction of any previously used language to start a fresh new conceptualization.

In [Uschold and Gruninger, 1996] authors devised their own *meta-ontology, using the natural language definitions as an implicit requirements specification. The main terms defined in the Enterprise Meta-Ontology were Entity, Relationship, Role, State of Affairs and Actor. These served as the basis for the formal coding stage.*

3.6.3 Families of Formalization Languages

3.6.3.1 Symbolic systems

Finally, *Ontologies implementation requires the use of an environment that supports the meta-ontology and ontologies selected at the integration phase. The result of this phase is the ontology codified in a formal language.* [Fernandez *et al.*, 1997].

A formalism framework provides a primitives with a fixed semantic and manipulation operators with a known behavior. A symbolic system alone means nothing, Hofstadter [1999] gives the example of the following symbolic system:

- symbols: 'u', 'p' and 'e'
- axiom schema: *x* p u e u *x* (where x is an arbitrary long string of symbol 'u')
- production rule: if *x* p *y* e *z* exists then *x* p *y* u e *z* u exists too. (where *x*, *y* and *z* are arbitrary long strings of symbol 'u')

This system can produce (well-formed) strings such as "uuu p uu e uuuuu" but cannot produce strings such as "uu p uu e u". Our point is that this system alone has no meaning. It just a symbolic system: a set of symbols, initial states and rules of manipulations that can produce new states of the system. It has no interest for the rest of the world until someone gives it an interpretation i.e. finds an isomorphism between the states and manipulations of the systems and the model and inferences of a domain. For instance in the previous system if "*x* p *y* e *z*" is interpreted as "x+y=z" we can see (and even prove) that the symbolic systems with this interpretation simulate the inference of addition. The interpretation is not unique ("*x* p *y* e *z*" could be interpreted as "x=z-y") but it gives its meaning to the systems by providing the rules according to which symbols, states and operations can be given sens. A symbolic system can be formally valid without any interpretation, but it needs an interpretation prove it is factually valid.

A formalism provides a symbolic system (syntax, axioms, inference rules, operators...) and the semantic attached to it (rules of interpretation attaching meaning to symbolic expressions). Thus for ontologies the stake is to find a formalism providing the adequate modeling primitives to capture the aspects of the ontology for which, according to the scenarios, it was deemed relevant to implement a formalization.

3.6.3.2 Logic of propositions

Logic is the foundation of formalization languages. It comes from a branch of philosophy (Logic) that analyzes inference and tries to provide a formal scientific method of examining or thinking about ideas . Logic develops Logical systems (logical languages with authorized manipulations) that are symbolic systems which interpretation provides a simulation of human inferences. The most basic logic is the propositional logic [Kayser, 1997]:

Syntax:
- logical symbols: $\supset$, **f** plus a, b, c,... plus (,)
- derivation rule: formula $\rightarrow$ f | a | b | c | ... | (formula $\supset$ formula)

Example of well-formed symbolic expression: (a $\supset$ (b $\supset$ c))

Axioms:
- (a $\supset$ (b $\supset$ a))
- ((c $\supset$ (a $\supset$ b)) $\supset$ ((c $\supset$ a) $\supset$ (c $\supset$b)))
- (((a $\supset$ **f**) $\supset$ **f**) $\supset$ a)

Notations / abbreviations for any formulae x and y
- **v**:= (**f** $\supset$ **f**)
- $\neg$x can be replaced by (x $\supset$ **f**)
- x$\vee$y can be replaced by ((x $\supset$ y) $\supset$ y)
- x$\wedge$y can be replaced by ((x $\supset$ (y $\supset$ **f**)) $\supset$ **f**)
- x$\equiv$y can be replaced by (((x $\supset$ y) $\supset$ ((y $\supset$ x) $\supset$ **f**)) $\supset$ **f**)

Inference rules:
- I1: Let a formula x contains a_i and an application $a_i \rightarrow z_i$ (z_i being a formula) then we create a new formula replacing a_i in x by z_i
  e.g. x = (a $\supset$ a) then ((a $\supset$ b) $\supset$ (a $\supset$ b) is inferred
- I2: if x, y et z are formulae and y is the formula (x $\supset$ z) then if x can be proven in the system z is inferred.

  modus ponens: $\dfrac{p,\ p \rightarrow q}{q}$

Figure 18 Definition of the logic of propositions

Without an interpretation this would just be a meaningless symbolic system i.e. a symbolic system that could not be used for any application since it cannot be interpreted

Interpretation:

Rules of valuation:
- V = { true, false} set of truth value

Model: function v
- v: s ∈ (a,b,c,...) → v(s) ∈ {true, false} **interpretation**: a, b, c are propositions true or false
- v: **f** → v(**f**) = false **interpretation**: **f** is always false
- v: (p ⊃ q) → true except if v(p)=true et v(q)=false **interpretation**: implication "if p then q"

Input		***Output***				
p	**q**	**p ∧ q**	**p ∨ q**	**¬ p**	**p ⊃ q**	**p ≡ q**
T	T	T	T	F	T	T
T	F	F	T	F	F	F
F	T	F	T	T	T	F
F	F	F	F	T	T	T

- ¬x **interpretation**: la negation " not x "
- x∨y **interpretation**: disjunction " at least one of the two is true "
- x∧y **interpretation**: conjunction " both are true "
- x≡y **interpretation**: equivalence " iff: if and only if both are true or both are false "

Figure 19 Interpretation of the logic of propositions

The propositional logic is the base for other logic. From ontology formalization point of view, it is too limited: propositions are indivisible symbols. The propositional logic only considers relations between propositions without considering the structure and the nature of the proposition. One of the consequences is that cannot represent the difference between individuals and categories and the relations between individuals. These differences are at the heart of ontologies and thus we need a more expressive language.

3.6.3.3 Predicate or first order logic:

In his Organon, Aristotle studied the categorical propositions:

Quantificator + Subject + Copula + Predicate

These are declarative statements (not interrogative or imperative) where the quantificator is "Universal" or "Particular" and the Copula is "Affirmative" or "Negative". Thus Aristotle distinguished four types of propositions:

- A: Universal affirmative: Every A is B e.g. Every Man is Mortal
- E: Universal negative: No A is B e.g. No Man is Immortal
- I: Particular affirmative: Some A is B e.g. Some Man is Blond
- O: Particular negative: Some A is not B e.g. Some Man is not Blond

A, E, I, O: (AffIrmo nEgO = I affirm, I deny) are the 4 basic "praedicatum" of Aristotle and they will be the foundations of an extension of propositional logic called predicate logic or first order logic. The Organon of Aristotle goes further, studying the inferences that can be done with these predicates, and especially the syllogisms: inferences starting from two propositions (premises) and to infer one new proposition (conclusion).

There exist 64 types of syllogisms among which 15 are interesting. Among these 15 syllogisms, 4 are at the heart of ontologies as noted by [Sowa, 2000b]:

Barbara	**Celarent**
A: Every animal is material. A: Every human is an animal. A: Every human is material.	E: No spirit is a body. A: Every human is a body. E: No spirit is a human.
Darii	**Ferio**
A: Every beast is irrational. I: Some animal is a beast. I: Some animal is irrational.	E: No plant is rational. I: Some body is a plant. O: Some body is not rational.
Principle of inheritance	**Principle of Coherence**

Figure 20 Main syllogisms used for ontologies

The logic of predicate or first order logic (FOL) includes the logic of propositions and can be defined as follows [Kayser, 1997]:

Symbols:
- logical symbols $\supset$, $\forall$ (universal quantificator "for every ...")
- variables x, y, ...
- fonctions g, h, ...
- prédicats f, p, q,...
- parenthesis (,)

Derivations: $pred_i$, $fonct_i$ are symbols of predicates / formulae of arity i, i.e. with i arguments
- formula $\rightarrow$ $pred_0$ | $pred_1$(term) | $pred_2$(term, term) | ... | (formula $\supset$ formula) | ($\forall$ var) (formula)
- term $\rightarrow$ $fonct_0$ | $fonct_1$(term) | $fonct_2$(term, term) | ... | var
- var $\rightarrow$ x | y | ...

Example of expression $(\forall x)\ (p(x) \supset ((\forall y)\ q(x,y)))$

Notations
- $\neg x$ la negation
- $x \vee y$ disjunction
- $x \wedge y$ conjunction
- $x \equiv y$ equivalence
- $\exists$ existential quantificator "there exists at least one..."
  $(\exists x)(f)$ can be replaced by the formula $\neg(\forall x)(\neg f)$

Figure 21 Definition of the logic of predicates

The addition of the universal quantificator and the predicates is sufficient to give us the ability to differentiate among individuals and categories and to express relations between individuals. For instance, in this logic we can now write: $(\forall x)\ (cat(x) \supset animal(x))$.

We will not detail here the complete interpretation of the interpretation of this logic, we just give a summary in Figure 22 and an example of modeling in Figure 23 :

Interpretation:

Rules of valuation:
- V = { true, false} set of truth value

Model: Domain D: non-empty set

Interpretation I:
- I: $fonct_n \rightarrow [\ f_n: D_n \rightarrow D\ ]$ $(fonct_0 \rightarrow constant)$
- I: $pred_n \rightarrow [\ p_n: D_n \rightarrow V\ ]$
- $pred_0 \rightarrow$ propositions
- $pred_1 \rightarrow$ subsets of D (class predicates e.g. cat(x))
- I: **f** $\rightarrow$ false

Assignation A: {x,y,...} $\rightarrow$ D

Evaluation
- $pred_n(term_1, term_2,...) \rightarrow p_n(d_1,d_2,...)$
- $(p \supset q) \rightarrow$ true expect if v(p)=true and v(q)=false
- $(\forall x)(a) \rightarrow$ false if there exists at least one x such that a is false; true otherwise

Figure 22 Interpretation of the logic of predicates

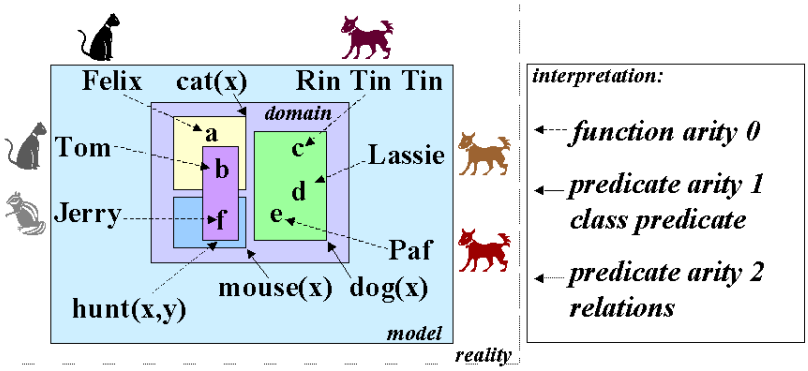


Figure 23 Example of modeling in FOL

The language CycL (Cycorp http://www.cyc.com/cyc-2-1/ref/cycl-syntax.html) used for the Cyc ontology is based on the logic of predicates. KIF [Genesereth and Fikes, 1992] is also based on first order logic and was developed as a Knowledge Interchange Format to solve the problem of heterogeneity of languages by proposing a lingua franca for knowledge exchange between independent systems. It is used by the Ontolingua server [Farquhar *et al.*, 1996]

This logic is much more expressive than the logic of propositions. However this illustrates the paradox of the expressiveness formalisms [Kayser, 1997]:
- Even if it is more expressive that the logic of predicates, there are things we cannot express, for instance we cannot give properties on relations e.g.: we cannot say (R) (transitive(R) $\equiv$ ($(\forall x)(\forall y)(\forall z)$ (R (x,y) $\wedge$ R (y,z) $\supset$ R (x,z))
- On the other hand this new logic in only semi-decidable i.e. there does not exist one algorithm to determine, in a finite time, if one expression is provable or not.

The knowledge representation languages we will see in the next section usually make some restrictions of the expressiveness to keep the expressiveness they desperately need and cut the rest so that the system is still usable.

3.6.3.4 Formalisms proposed by Knowledge Representation Community

We will not go into the details of every formalisms. We only gives an overview of the formalisms available. These different languages have to be evaluated and compared bearing in mind the tradeoff between expressiveness and efficiency, usability and reusability...

3.6.3.4.1 Conceptual Graphs

Conceptual graphs (CG) [Sowa, 1984] [Sowa, 2002] come from a merging between existential graphs (Peirce) and semantic networks (Quillian). This formalism was motivated by needs natural language processing and needs for nice presentation of logic to human. There are several levels of extensions to CGs starting from original simple graphs: there exist an extension for nested graphs and contexts, another for rule graphs for inferences, another for actors enabling procedural attachment...

Graphs have several representation:

- DF (Display Form): a graphic representation
- LF (Linear Form): a textual linear equivalent of the DF
- CGIF (Conceptual Graph Interchange Format): for transmission between systems

A CG is a bipartite oriented graph i.e. there are two types of nodes in the graph (concept nodes and relation nodes) and the arcs are oriented and always link a concept node to a relation node (or vice versa). They are existential and conjunctive statements. Relations are n-adic i.e. their valence is an integer n giving the number of concept they can be linked to. Concepts and relations have a type. The types are primitive or defined. The definition is given by a λ-expression i.e. a graph with formal parameters λ_i that give the definitional pattern. Types of relations also have a fixed valence (giving the number of concept linked by the relation) and a signature (giving the type of concepts linked by the relation). Concept and relation types are organized in a two hierarchies structured by the subsumption relation. One of the most useful operator in the CGs is the projection: it allows

Nested graphs introduce context that are concept nodes with a CG inside. They allow, for instance, a CG to be the subject of another CG. The contexts can be nested.

Rule graphs allow graphs to describe IF... THEN rules to infer new CGs from known facts.

Known platforms implementing CGs are: CoGiTo & CoGITaNT, Notio (API Java), CharGer (CG editor), WebKB (CG in information retrieval), CG Mars Lander (Question-Answer system), Prolog+CG - (object-oriented extension of PROLOG, based on CG implemented in JAVA), Project Peirce (A collaborative project for developing a CG workbench), Synergy etc.

3.6.3.4.2 Topic Maps

Topic Maps [Biezunski *et al.*, 2001] is representation proposed by the librarian and documentalist community to index electronic documents, manage glossaries, thesaurus and catalogs, enable merging of indexes. There exist now an XML language XTopic to exchange Topic Maps.

A Topic reifies a subject in the form of multi-headed link pointing to occurrences of this subject in a mass of documents. The "subject" of a topic is the thing that it is about. Topics are instantiated outside the information sources and they collectively comprise a topic map.

Roles are subgroups of occurrences of a topic, for instance there can be a role "mention" and a role "definfition".

Topics are grouped in classes called "topic types". A topic type is a category to which one given topic instance belong. Topic types are organized in a subsumption hierarchy.

A Topic can have three types of names: a base name / designation name; a display name that can even be a graphic; a sorting name.
Topics can be related together through some association expressing given semantic, an association is a relation constrained to only relate topics together. An example given in [Biezunski *et al.*, 2001] is an "employment" association that can be used to describe the relationship between a person (employee) and a company (employer).

A Characteristic of a topic is a set of names, occurrences and roles for this topic. These names, occurrences and roles are called the scope of the topic and enable us to define point of view or profiles on a topic e.g.: for a given profile of user the system will use a given subset of names, occurrences and roles.

Facets are filters on Topics Maps, for instance they enable to extract from a multilingual topic map a precise language.

3.6.3.4.3 Frame and Objet oriented formalisms

Object Oriented Formalisms [Ducourneau, 1998] propose to represent, capture organize and manipulate knowledge through the notion of virtual objects representing real objects. In these formalisms there exist two basic entities: object classes and object instances.

Classes are categories of objects. A class defines the characteristics shared by all the objects of this category. Classes are structured in an inheritance hierarchy defined by the link "a-kind-of".

A class can be instantiated i.e. one can create an object belonging to this class. Instances are final objects instantiated from a class. Instances are linked to their class by a link "is-a". An instance has a unique identifier and attributes. Every attributes has a list of facets giving the value and characteristics of the attribute.

The semantic of inheritance is the one of inclusion of sets i.e. the instances of a subclass also belong to the instances of its super class. Subclasses inherit attributes and facets; they can enrich these definitions by adding new attributes, new facets or by refining constraints.

Facets can be declarative or procedural to precise the nature (type, domain, cardinality, value) or the behavior of an attribute (default value, daemon i.e. procedures to calculate the value, constraints, filters).

A mutation is the operation of trying to change the class of an object. This operation is at the heart of the classification algorithms of Object oriented frameworks that try to automatically classify instances according to their characteristics.

Points of view can be defined to build different hierarchies of classes capturing different conceptualizations while enabling an object to inherit from all the aspects defines for its class in the different views.

Graphic modeling languages (OMT, UML) have been proposed that look like Graph-oriented languages.

Object oriented data bases also offers interesting schema definition capabilities and additionally provide efficient data storage and retrieval mechanisms based on object query languages.

Examples of Object oriented systems are: FRL: MIT 70, RLL: Lenat 80, SRL: Fox 78-85, KRL: Xerox, Units, KL-one, , Shirka, Smeci Yafool & Y3, Troeps, Arome, Frome, etc. Object oriented data bases include O2, Ontos, ITASCA, Gemstone, Objectstore, Versant, Matisse, Objectivity/DB, etc.

OKBC [Chauddri *et al.*, 1997] : Open Knowledge Base Connectivity is a protocol with an object-based representation language. XOL [Karp *et al.*, 1999] is a light version of OKBC with an XML syntax.

FLogic [Kifer *et al.*, 1995] integrates frame-based and object -based languages and first order logic.

3.6.3.4.4 Description Logics

Description logics [Ducourneau, 1998] [Kayser, 1997] are drawing upon predicate logic, semantic networks and frame languages. There again there are two levels: the terminological level where concepts and roles are represented and manipulated and the factual level where assertion and manipulations are made about individuals. Thus, descriptions are concepts, roles and individuals. A concept is a generic entity of an application domain representing a set of individuals. An individual is a particular entity, an instance of a concept. A role is a binary relation between individuals. There exists two syntaxes for this logic:

C,D $\rightarrow$	A |	
	Top |	$\top$ |
	Bottom |	$\bot$ |
	(and C D) |	C $\cap$D |
	(not A) |	$\neg$A |
	(all r C) |	$\forall$r.C |
	(some r)	$\exists$

The description of a role can be primitive or defined. A definition uses the above constructors to give the roles attached to a concept and the restrictions of the roles (co-domain).

There exist different languages and families of descriptions logics:

- $\mathcal{AL}$ language: minimum languae $\mathcal{AL}$ = {T,⊥, ¬A,C∩D, ∀r.C, ∃r } A is a primitive concept, C and D are defined concepts and r is a role.
- $\mathcal{FL}$ et $\mathcal{FL}^-$ of Brachman $\mathcal{FL}$ = {C∩D, ∀r.C, ∃r, r|C } where r|C can be written (restrict r C) and introduces a constraint on the co-domain of the role r. $\mathcal{FL}^-$ = {C∩D, ∀r.C, ∃r}
- $\mathcal{PL}_1$ et $\mathcal{PL}_2$

A language can then be declined in a family of more expressive languages e.g. for $\mathcal{AL}$:

- $\mathcal{AL}$ = {T,⊥, ¬A,C∩D, ∀r.C, ∃r }
- $\mathcal{ALC}$ = $\mathcal{AL}$ ∪ {¬C} negation of defined concepts
- $\mathcal{ALU}$ = $\mathcal{AL}$ ∪ {C∪D} disjunction of defined concepts
  ⊥ ≡ C ∪¬C and C∪D ≡ ¬(¬C∩¬D)
- $\mathcal{ALE}$ = $\mathcal{AL}$ ∪ {∃ r.C} or c-some
  typed existential qualification
  ∃r ≡ ∃ r.T and ∃ r.C ≡ ¬(∀r. ¬C)
- $\mathcal{ALN}$ = $\mathcal{AL}$ ∪ {≥n r, ≤n r} or atleast and atmost
  cardinality: minimum and maximum number of values.
- $\mathcal{ALR}$ = $\mathcal{AL}$ ∪ {r1∩r2} or (and r1 r2)
  conjunction of roles

Then these exetensions can be composed to create even more expressive languages the biggest one being $\mathcal{ALCNR}$ = $\mathcal{ALCUENR}$ because C∪D ≡ ¬(¬C∩¬D) ∃ r.C ≡ ¬(∀r. ¬C).

Of course this expressively is at the cost of efficiency.

Examples of systems based on Description logics are: LOOM [Mac Gregor, 1991], Classic, Back, Kris, K-Rep, KL-One...

OIL [Fensel *et al.*, 2000] is an extension of the XML language RDF(S) - see the section on RDF(S), references are RDF [Lassila and Swick, 1999] and RDFS [Brickley and Guha, 2000]. It is based on descriptions logics.

NB: A comparison of several of these languages is given in [Corcho and Gómez-Pérez, 2000]

3.7 Reuse, Merging, Integrating

As quoted in a previous part, [Mizoguchi *et al.*, 1997] explains that *one of the key issues is 'de-contextualization' of the knowledge. Needless to say, every piece of knowledge is tuned to a context in which it is expected to apply. The first thing we have to do is to formalize the context and then, to establish a shared terminology.* Mizoguchi insists and explains that it is *necessary for making knowledge and components reusable.*

The reuse of ontologies is both seductive (it should save time, efforts and would favor standardization) and difficult (commitments and conceptualizations have to be aligned between the reused ontology and the desired ontology). But [Guarino, 1997] is right saying that *a concept may be 'relevant' for a particular task without being necessarily 'specific' of that task.* Therefore reuse should be possible and pursued. *One should try to integrate as much as possible existing ontologies in one's ontology.* [Fernandez *et al.*, 1997]

The approach taken in the project described in [Bernaras *et al.*, 1996] is interesting: *The feasibility of knowledge reuse is investigated by creating ontologies for particular domains and reusing them for different tasks or applications. This can be called domain-oriented reuse.*

The authors say that *modularization and Hierarchical organization are good for usability and reusability. Standardization and Abstraction have to be used with care (...) However, theoretical distinctions for structuring ontologies can be practically difficult to operationalize. Our ontology building shows that modularization is a very good Ontology Design Strategy. On the other hand, further theoretical distinctions can be difficult to maintain in practice.*

Ontologies are developed for the purpose of reusability and shareability of knowledge, and reusability is directly linked with generalization, i.e., generic concepts are usually more reusable than specific ones. The desired scope of reusability is a very important decision that has to be taken before an ontology is designed. Although it is true that generic concepts are in general more reusable, the reuse of generic concepts for

specific applications may involve, in certain cases, a big design effort to translate the generic concepts into specific ones. This effort has to be seriously considered during the design of an ontology, and compared with the effort of reusing, for example, an ontology built of specific concepts belonging to related applications. [Bernaras *et al.*, 1996].

As for the other points, several tendencies exist in the community. [Fernandez *et al.*, 1997] says *ontologies are built to be reused or shared, anytime, anywhere, and independently of the behavior and domain of the application that uses them*. [Uschold and Gruninger, 1996] also commented on that point talking of the extensibility of an ontology: *An ontology should be designed to anticipate the uses of the shared vocabulary. It should offer a conceptual foundation for a range of anticipated tasks, and the representation should be crafted so that one can extend and specialize the ontology monotonically. One should be able to define new terms for special uses based on the existing vocabulary, in a way that does not require the revision of existing definitions.*

The author of [Fernandez *et al.*, 1997] believes that *with the goal of speeding up the construction of your ontology,* one *might consider reuse of definitions already built into other ontologies instead of starting from scratch. In this case,* they *propose the following:*

1. *Inspect meta-ontologies (i.e., in Cyc, in Ontolingua, ...) to select those that better fit your conceptualization. The goal is to guarantee that the sets of new and reused definitions are based upon the same set of basic terms. If existing meta-ontologies are not appropriate for your ontology, you should start the definition and implementation of a new meta-ontology in a formal language.*
2. *Whether or not you reuse existing meta-ontologies, the next step is to find out which libraries of ontologies provide definitions of terms whose semantic and implementation is coherent with the terms identified in your conceptualization. Once you have chosen the most appropriate terms, if the meta-ontology upon which those terms have been built is different of the meta-ontology used to build the yours, you should check the existence of translators to transform definitions into your target language.*

Translation is a very delicate point, especially because it is limited to the formal part of the ontology and that it is only one of the problems raised by the reuse of ontologies (different commitments may be difficult to conciliate).But even the formal translation has limitation, for instance *translation into less expressive languages means that translation will necessarily be incomplete.* [Uschold and Gruninger, 1996]

An idea discussed in the community is the possibility of building libraries of ontologies. Then comes the problem of indexing, characterizing and comparing the relevance of ontologies in the library for a given new problem. One proposition is to base the classification of ontologies on the description of the problems, context, perspective that were in the mind of their creators. [Uschold and Gruninger, 1996] discussed that point: *Another important issue in the use of ontologies is the notion of a library of ontologies which can be adapted to different classes of problems. The challenge in this case is to determine which ontologies are the most appropriate for a given problem. They proposed that the ontologies may be distinguished by their corresponding competency questions; that is, one ontology may be able to represent a different set of competency questions than another ontology. In this case, the relationship between the ontologies can be formally represented by the questions.*

Therefore it is interesting to try to assist and favor the reuse of ontology even if it is just a bootstrapping.

[Guarino, 1997] defend *the thesis of the independence of domain knowledge. This thesis should not be intended in a rigid sense, since it is clear that – more or less – ontological commitments always reflect particular points of view (for instance, the same physical phenomenon may be described in different ways by an engineer, by a physicist or by a chemist); rather, what* [Guarino stresses] *is the fact that reusability across multiple tasks or methods can and should be systematically pursued even when modeling knowledge related to a single task or method: the more this reusability is pursued, the closer we get to the intrinsic, task-independent aspects of a given piece of reality (at least, in the commonsense perception of a human agent).*

On the other hand, [Bachimont, 2000] observed that *it emerges from practice that it is always possible to adapt an ontology but never possible to reuse it as it is.* [Uschold and Gruninger, 1996] also remarked that *during either both of the capture and coding processes, there is the question of how and whether to use [all or part of] ontologies that already exist. (...) It is easy enough to identify synonyms, and to extend an ontology where no concepts readily exist. However, when there are obviously similar concepts defined in existing ontologies, it is rarely clear how and whether such concepts can be adapted and reused.*

It is still interesting to notice that here again, the natural language version of the ontology could be used. It could be, for example, integrated in the initially analyzed corpus to enrich the terminological study, and suggest other aspects that were not captured in the formal version but still implicit in the natural language definitions and interesting in a new application context.

Following [Sowa 2000b] we can say that each of the three basic fields at the heart of ontology-oriented modeling Logic, Ontology, and Computation, presents a different class of problems for knowledge sharing and thus for ontology sharing and mapping between different ontologies :

- Logic: *Different implementations support different subsets and variations of logic. Sharing information between them can usually be done automatically if the information can be expressed in the common subset. Other kinds of transfers may be possible, but some of the information may be lost or modified.* [Sowa 2000b]. Thus the very first problem is the differences of expressiveness between the formalisms. Loss will occur as soon as a translation lacks the needed expressiveness in the target language.
- Ontology: *Different systems may use different names for the same kinds of entities; even worse, they may use the same names for different kinds. Sometimes, two entities with different definitions are intended to be the same, but the task of proving that they are indeed the same may be difficult or impossible* [Sowa 2000b]. We saw that the granularity and the scope of the ontologies was very much dependent on the application scenario. Thus an ontology may be interesting for its domain, but hardly reusable because it was tuned for a completely different application. However, the natural language definitions, comments and documents of the ontology can still be exploited since they represent a highly relevant corpus for text analysis.
- Computation: *Even when the names and definitions are identical, computational or implementational side effects may cause the same knowledge to behave differently in different systems. In some implementations, the order of entering rules and data may have an effect on the possible inferences and the results of computations. Sometimes, the side effects may cause a simple inference on one system to get hung up in an endless loop on another system* [Sowa 2000b]. The importance of computational commitment is vital since it is not respected it will spoil the logical and ontological consensus. The inference intensions should be captured, documented and publish to enable exchanges, consensus and checks. Rule languages are, in some way, a means to do it.

3.8 Documenting

We have seen the importance of keeping the natural language definitions and comments in the formalized version it is a first and extremely important step in documenting the ontology and its life. Recall the remark from [Uschold and Gruninger, 1996]: *An ontology should effectively communicate the intended distinctions to humans who design agents. This means that ambiguity should be minimized, distinctions should be motivated, and examples should be given to help the reader understand definitions that lack necessary and sufficient conditions. (...). In all cases, definitions should be documented with natural language and examples to help clarify the intent.*

The design rationale of the ontology should be capture because it explains what motivated its actual state and helps people understand and may be commit or adapt it. [Uschold and Gruninger, 1996] assert that *all important assumptions should be documented, both about the main concepts defined in the ontology, as well as the primitives used to express the definitions in the ontology (i.e. the meta-ontology).* An important use of the documentation is also the maintenance or reuse processes. [Fernandez *et al.*, 1997] believes that *the absence of a sound documentation is also an important obstacle when you reuse/share ontologies already built. So, if you wish your ontology to be reused/shared by others try to document it as best you can.*

As noted in [Fernandez *et al.*, 1997], *METHONTOLOGY includes the documentation as an activity to be done during the whole ontology development process. In fact, after the specification phase, you get a requirements specification document; after the knowledge acquisition phase, a knowledge acquisition document; after the conceptualization, a conceptual model document that includes a set of intermediate representations that describe the application domain; after the formalization, a formalization document; after the integration, an integration document; after the implementation, the implementation document; and during the evaluation, an evaluation document.*

We insist on the fact that documenting is not only interesting for designers, the document can prove to be a strong asset to encourage the appropriation of the ontology by the users of the system exploiting this ontology.

3.9 Review & Evaluation

Evaluation means to carry out a technical judgment of the ontologies, their software environment and documentation with respect to a frame of reference (in our case the requirements specification document) during each phase and between phases of their life cycle. Evaluation subsumes the terms Verification and Validation. Verification refers to the technical process that guarantees the correctness of an ontology, its associated software environments, and documentation with respect to a frame of reference during each phase and between phases of their life cycle. Validation guarantees that the ontologies, the software environment and documentation correspond to the system that they are supposed to represent. [Fernandez *et al.*, 1997]

One of the first aspect to be ensured is the coherence of the ontology: *An ontology should be internally consistent. At the least, the defining axioms should be logically consistent. Coherence should also apply to the parts of the definitions that are not axiomatic, such as the natural language documentation and examples.* [Uschold and Gruninger, 1996]

Concerning the whole life cycle of the ontology, an interesting suggestion can be found in [Uschold and Gruninger, 1996]. The authors proposed to formally describe the ontology specification. *A declarative specification of an ontology provides a characterization that is independent of how the ontology is implemented. It allows us to reason about what the ontology is designed for, rather than how the ontology supports this reasoning.* What could be checked then is:

- *No Extra-Ontological Distinctions: Key distinctions are made within the language, so that all conclusions can be drawn from the ontology alone. (…)*
- *No Hidden Assumptions: All assumptions are made explicit. This is also addressing the challenge of shared understanding - what is an obvious assumption for one person is not obvious to another. As long as these assumptions remain implicit, the potential for disagreement is present. (…)*
- *Design Options: There may be several ways of representing any given problem, and we often need to search through these different possibilities. (…) A declarative specification of an ontology provides a precise and rigorous characterization of this design search space. If the specification is consistent with the axioms of the ontology, then it is a possible alternative model.*
- *Ontological Commitments: An ontology is a specification used for making ontological commitments. Practically, an ontological commitment is an agreement to use a vocabulary (i.e. ask queries and make assertions) in a way that is consistent with respect to the theory that specifies the ontology. We build agents that commit to ontologies and we design ontologies so we can share knowledge with and among these agents. (…)*
- *Modifiability: If we change part of the ontology, we need to determine what else must be changed. With a declarative specification, we have a precise characterization of the relationships among different sets of constraints used to represent a problem. Without such a specification, these relationships may not be explicitly represented but instead be implicit in some partially shared understanding (which not everyone may actually share).*
- *Re-Usability: By characterizing classes of domains and tasks within these domains, ontologies provide a framework for determining which aspects of an ontology are reusable between different domains and tasks.*
- *Adequacy Criteria: A declarative specification allows us to define rigorous criteria for adequacy.*

The authors, here also, use the competency questions presented at the beginning: *Once the competency questions have been posed informally and the terminology of the ontology has been defined, the competency questions are defined formally as an entailment or consistency problem with respect to the axioms in the ontology. They use these competency questions to evaluate the ontological commitments that have been made to see whether the ontology meets the requirements.*

[Fernandez *et al.*, 1997] rightly declares *that you can not prove the total completeness of your ontology specification document (any time, anywhere, someone may find a new relevant term to be included). But before making your ontology available to others, you should evaluate it, that is, make a technical judgment with respect to a frame of reference.*

The review process should involve the end-users since they are the usability judges. Review should be done all during the life cycle and as with any change or decision, it should be documented: *Critically review definitions, revising as appropriate; where important decisions were made overturning previous decisions, keep track of the changes as a set of historical notes.* [Uschold and Gruninger, 1996]

3.10 Conclusion: The ontologist commitments and other transversal remarks

To close these considerations on designing and formalizing ontologies, we recall the conclusion of [Bachimont, 2000]: *An ontology is the result of a modeling. The modeling concerns the characterization of primitives for the formal representation of knowledge. These primitives are not data from the domain that we would just have to identify, but theoretical constructions for the purpose of the modeling. An ontology is characterized according to three levels:*

1. *Semantic or interpretative level: regional ontology. The ontology is a tree of semantic concepts. A semantic concept is characterized by a linguistic wording coming from the domain language and which interpretation is constrained by the differential principles, the ones that are directly associated to it plus the ones inherited from its ancestors in the tree. These principles correspond to the semantic commitment that must be respected so that the wording has an unambiguous and non contextual meaning and so that it can be used as a representation primitive. Two semantic concepts are identical if the interpretation of the wording through the differential principles leads, for each concept, to an equivalent meaning.*
2. *The formal or referential level: referential ontology. The ontology is a lattice of formal concepts. The formal concepts are characterized by a wording which semantics is defined by an extension of objects. Formal concepts are either semantics concepts from which we reuse the wording and to which we associate referents in accordance with the semantic commitment, or new concepts formally defined by the intersection of formal concepts already defined. Each one of the formal concepts is defined by an ontological commitment that specifies which are the objects that must exist in a domain to use the concept in accordance with its formal definition. Two formal concepts are identical if they always have the same extension.*
3. *The operational or computational level: computational ontology. The ontology is a lattice of computational concepts. The computational concepts are characterized by the operations that can be performed on them: these operations give them a semantics in the effective system built. Then the commitment becomes computational: it consists of the set of operations that can be applied to each concept. Two computational concepts are identical if they have the same inferential potential.*

An ontology depends not only on the domain but also on the targeted task. It is the intended context of the task that enables us to fix the relevant meaning features of semantic concepts to cancel out the context effect.

[Uschold and Gruninger, 1996] also recognizes the importance of ontological commitments and stresses the need for keeping it minimal: *An ontology should require the minimal ontological commitment sufficient to support the intended knowledge sharing activities. An ontology serves a different purpose that a knowledge base, and therefore a different notion of representational adequacy or completeness applies(...) An ontology should make as few claims as possible about the world being modeled, allowing the parties committed to the ontology freedom to specialize and instantiate the ontology as needed.(...) While making too many ontological commitments can limit extensibility, making too few can result in the ontology being consistent with incorrect or unintended worlds (i.e. models). For this reason, it is beneficial to make ontological commitments with respect to aspects* ***intrinsic*** *to a domain.*

Finally, [Guarino and Welty, 2000] rightly recalls that *the everyday use of these analysis tools ultimately depend on the assumptions resulting from our conceptualization of the world and is ultimately the result of our sensory system, our culture, etc.*

Chapter 4 : OVERVIEW OF THE APPROACH ADOPTED IN THE COMMA PROJECT

In this chapter we identify and describe the different needs for an ontology and models in the CoMMA system, for which O'CoMMA (Ontology of CoMMA) was designed, and we position them within the rest of the architecture. We start from overall observations and requirements on the organizational memory then we emphasize the interest of annotations for agents and finally we describe the schema of a model-based memory chosen in CoMMA to fulfill these requirements.

4.1 Introduction

With our entrance in the information society there has been a shift in economical rules of game forcing corporations to adapt their organization and management in order to improve their reaction and adaptation time. Information systems became backbones of the organizations enabling project-oriented management and virtual teams, therefore the industrial interest in methodologies and tools enabling capitalization and management of corporate knowledge grew stronger. The semantic web technologies provide interesting techniques to materialize and structure memories to prepare their exploitation and management. At the same time, distributed artificial intelligence proposes appropriate paradigms, especially the multi-agents one, to deploy a software architecture over this distributed information landscape and through intelligent collaboration achieve a global capitalization of the corporate knowledge while being able to locally adapt to individual resources and users specificity.

In order to support corporate memory activities involved in the new employee scenario and the technology monitoring scenario of CoMMA, we decided to introduce user models (profiles) and enterprise models. These models are referenced and used in conjunction with document annotations structuring, indexing, the corporate memory. Models enable the CoMMA system to get insight in the organizational context and take into account the users' characteristics; the system can intelligently exploit the aspects described for the interaction between agents and overall between agents and users. To explicit models and annotations, we need a conceptual vocabulary, and this is where an ontology was first needed. The following section briefly covers the overall approach of CoMMA, motivating and explaining the different needs for O'CoMMA.

4.2 Organizational memory

A corporate memory is an explicit, disembodied and persistent representation of knowledge and information in an organization, in order to facilitate their access and reuse by members of the organization, for their tasks [Dieng *et al.*, 2001]. The stake in building a corporate memory management system is the coherent integration of this dispersed knowledge in a corporation with the objective to "promote knowledge growth, promote knowledge communication and in general preserve knowledge within an organization" [Steels, 1993].

The CoMMA project intends to implement the system in the context of two scenarios:

- The insertion of new employees in the company: how can a corporate memory speed-up the process of integration of a new employee by bringing the needed information to the newcomer at the right time and the right order;
- The support of technology monitoring: how can a corporate memory assist the diffusion of information acquired by the technology monitoring departments and provide it or even push it to the right people.

In both scenarios, the actors (ex: tutor/tutee, technical area referents...), the information (ex: newcomer route card, technology trend analysis card...) and the actions performed on the memory (ex: adding an annotation, pushing/pulling information...) are distributed and heterogeneous by nature. The conceptual and technical choices of CoMMA are mainly motivated by these three observations:

(1) The corporate memory is, by nature, an heterogeneous and distributed information landscape. The corporate memories are now facing the same problem of information retrieval and information overload as the Web. To quote John Naisbitt "we are drowning in information but starved of knowledge". The

initiative of a semantic Web [Berners-Lee *et al.*, 2001] is a promising approach where the semantics of documents is made explicit through metada and annotations to guide later exploitation. Ontobroker [Decker *et al.*, 1999], Shoe [Heflin *et al.*, 1999], WebKB [Martin and Eklund, 1999] and OSIRIX [Rabarijaona *et al.*, 2000] are examples of this technique, relying on annotation based on ontologies. XML being likely to become an industry standard for exchanging data, we use it to build the structure of the memory and especially RDF (Resource Description Framework) that allows the resources of the memory to be semantically annotated. The corporate memory can then be studied as a "corporate semantic Web". ⇒ **The memory is composed of heterogeneous changing documents, we structure them using semantic annotation expressed with primitives provided by a shared ontology. RDF and RDFS provide the framework to write the annotations and formalize the ontology in a schema.**

(2) The population of the users of the memory is, by nature, heterogeneous and distributed in the corporation. Agents will also be in charge of interfacing users with the system. Adaptation and customization are a keystone here and CoMMA relies on machine learning techniques in order to make agents adaptive to users and context. This goes from basic customization to user's habits and learning of preferences, up to push technologies based on interest groups and collaborative filtering. ⇒ **The description of the different user groups, profiles and roles involved in the two scenarios, uses the primitives of the ontology to make explicit, share and exploit a model of the organizational environment and user population.**

(3) The tasks to be performed on the corporate memory are, by nature, heterogeneous and distributed. The corporate memory is distributed and heterogeneous. The user population is heterogeneous and distributed. Therefore, it seems interesting that the interface between these two worlds be itself heterogeneous and distributed. As noted in [Wooldridge *et al.*, 1999], programming progresses were achieved through higher abstraction enabling us to model more and more complex systems. Multi-agents systems (MAS) are a new stage in abstraction that can be used to understand, to model and to develop a whole new class of distributed systems. The MAS paradigm appears to be suited for the deployment of a software architecture above the distributed information landscape of the corporate memory. On the one hand, individual agents locally adapt to users and resources they are dedicated to. On the other hand, thanks to cooperating software agents distributed over the network, an integrated and global view of the corporate memory can be capitalized. ⇒ **Semantic level message passing between agents enables cooperation for a global capitalization. It relies on a shared semantic of the primitives used in the messages; the shared semantic is captured by the ontology.**

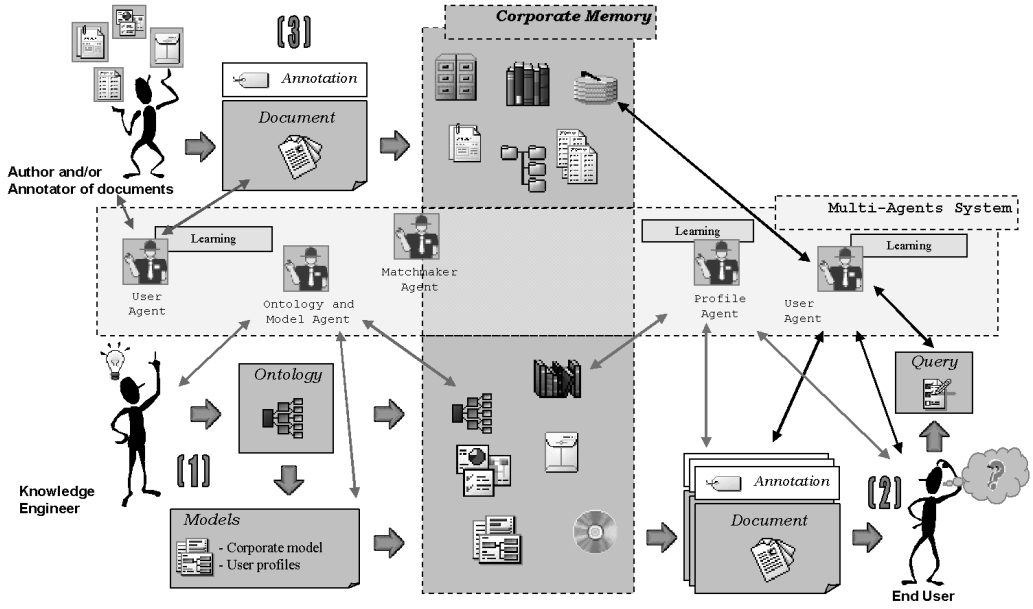


Figure 24 Schematic view of the CoMMA solution for Knowledge Management

In CoMMA the Agent Paradigm also proved its interest for software engineering and distributed implementation: agents and their behavior can be developed by the partners of the project that have the skills and the tools needed (e.g.: machine learning, semantic search engine...) and the integration will be done at the semantic level based on a shared ontology. Thus in CoMMA Agents, as loosely couple software components, proved to be interesting for development, integration phase, deployment and exploitation.

The ontology is not only a seminal conceptual tool, it is also an explicit element of the memory which captures some views, opinions, definitions and characteristics of the organization. It provides a lexicon of the organizational world (company policies, organizational structures and processes vocabulary). This shared vocabulary promotes efficient and non-ambiguous communication (ex: exchange between a technology monitor and an engineer interested by a piece of information) and makes explicit, in a reference document, the organizational jargon enabling people to understand the 'company language' (ex: a newcomer can find in the ontology the meaning of some internal concepts) ⇒ **Ontology is not only a tool for document annotation and communication support, it is a full component of the memory highly relevant in itself for both scenarios.**

4.3 Agents in an annotated memory

We will not discuss the definition of an agent here. In the project we tend to refer and use the weak notion of agency [Wooldridge and Jennings, 1995]. We do not claim that all our agents are currently one hundred percents compatible with this definition, but it is this definition that we use to consider what could be an agent and what will have to be something else. The information agents are part of the so-called 'intelligent agents', a notion nicely commented by Lieberman [1999]. A Multi-Agents System (MAS) can be defined as a loosely coupled network of agents that work together as a society aiming at solving problems that would generally be beyond the reach of any individual agent. Such a system is said to be heterogeneous when it includes agents from at least two or more agent classes. A Multi-Agents Information System (MAIS) is then defined as a MAS aiming at providing some or full range of functionality for managing and exploiting information resources. The application of MAIS to corporate memories means that agents' cooperation aims at enhancing information capitalization in the company. Based on these notions we define the CoMMA software architecture as an heterogeneous MAIS.

Unlike a lot of other MAIS projects we do not stress the heterogeneous sources reconciliation aspect: documents are heterogeneous but annotations are in RDF and based on a shared ontology. We are focusing on the design of an architecture of cooperating agents, being able to adapt to the user, to the context, and supporting information distribution. The duality of the definition of the word 'distribution' reveals two important problems to be addressed: (1) Distribution means dispersion, that is the spatial property of being scattered about, over an area or a volume; the problem here is to handle the naturally distributed data, information or knowledge of the organization. (2) Distribution also means the act of distributing or spreading or apportioning; the problem then is how to make the relevant pieces of information go to the concerned agent (artificial or human).

Figure 24 shows the CoMMA architecture overview. Agents are able to communicate with the others to delegate tasks, and to make elementary reasoning and decisions. They have inference mechanisms exploiting ontologies. They help authors of documents to annotate the documents, to diffuse the acquired innovative ideas to the interested employees of the company or proactively suggest to newcomers the information essential for their integration. We identified four sub-societies of agents. A detailed presentation of these societies is out of the scope of this article and more can be found on that subject in [Gandon *et al.*, 2000]. However we would like to stress the pivotal role of the ontology agent sub-society, that provides a common context as a semantic grounding that is vital for agents interoperation [Singh and Huhns, 1999]. These agents provide downloads, updates and querying mechanisms of the ontologies for other agents. They provide, for instance, the user agents with the ontological elements needed for query elicitation and the mediators or resource agents with the ontological elements needed for query solving. When the system handles several ontologies, ontology agents may be in charge of the mapping and translation between ontologies using, for instance, mappings to a common ontology. When the system handles different points of view, they enable other agents to use them to filter their view/access to the ontology. When there exists a terminological level, additional services such as queries on terms and synonyms for a given concept may be part of their job. The ontology is vital to the agent communication and interaction protocols. From these interactions, emerge at the societal level the functionalities meeting users requirements. CoMMA adopted the Java JADE [Bellifemine *et al.*, 2001] platform for MAS development; this platform being developed by one of the partners of the project and compliant with FIPA standards. The agent communication language FIPA ACL is based, like its counterpart KQML, on the speech act theory coming from the work of J. L. Austin [1975] on locution, illocution, and perlocution. We can now distinguish two sources of a need for ontologies in MAIS, one coming from the very nature of the MAS where agents need a conceptual vocabulary to formulate their messages, to talk about themselves and the system, and a second one coming from the information management system using ontology-based annotations and messages. It is the second one that will be discussed here.

In their article about "Agents in Annotated Worlds" Doyle and Hayes-Roth [1998] explained that software agents must have the ability to acquire useful semantic information from the context of the world

they evolve in, "knowledge can literally be embedded in the world as annotations attached to objects, entities and locations". They introduce the notion of "annotated environments containing explanations of the purpose and uses of spaces and activities that allow agents to quickly become intelligent actors in those spaces". Although the authors choose for their application domain, the field of believable agents inhabiting and guiding children in virtual worlds, their remark is transposable to information agents in complex information worlds. This leads us to say that annotated information worlds are, in the actual state of the art, a quick way to make information agents smarter. If the corporate memory becomes an annotated world, agents can use the semantics of the annotation and through inferences help the users exploit the corporate memory. CoMMA makes use of RDF(S) formalism based on XML technology and described in a following section. As shown in Figure 25 the content languages of messages in CoMMA are either SL0 either RDF. The SL language is used to describe speech acts when designing agents' interactions and behavior. RDF is used for memory annotations and query formulation.

(a) Enveloppe FIPA ACL - **(b)**Requête SL0 CoMMA - **(c)**Pattern RDF

Figure 25 Example of message from an agent requesting memos with their title.

4.4 About enterprise modeling

We do not intend to make a complete state of the art of enterprise modeling, because as we shall see the field of enterprise modeling is very large and the major part of contributions in this domain is noticeably different from our concerns in CoMMA. However some interesting points have been selected and are reported here.

[Rolstadås, 2000] starts by reminding us that a *model is an abstract representation of reality expressed in terms of some formalism. If A is a model of reality B for observer C, C can use A to obtain information on B. This is important to bear in mind. A model is in any case only an approximation of reality. This introduces of course limitations in the application of models.*

Therefore, *an enterprise model is used to "describe" an enterprise.* The author quotes several definitions of the enterprise model: some tend to adopt more generic definitions than others, they vary in their focus and in their definition of an enterprise, some have single view others handle multiple views, and so on.

In [Solberg, 2000] Claus Solberg explains with reference to [Vernadat, 1996] that *enterprise modeling is the set of activities, methods and tools related to developing models for various aspects of an enterprise. In fact, there already exists an enterprise model in any company, be it small or large. The problem is that it is poorly formalized. It exists in the form of organization charts established by management, documented operational procedures, regulation texts, and to a large extent in the vast amount of enterprise data in databases, knowledge bases, data files, and code of application programs. However, a large part remains in the minds of people and is not formalized or even documented at all. Methods and tools are required to capture, formalize, maintain, and use this knowledge for better operation and control of complex systems such as manufacturing enterprises.*

[Szegheo, 2000] wrote that *an enterprise model is one representation of a perception of an enterprise. It can be made of several sub-models including (but not limited to) process models, data models, resource*

models and organization models. The author also explains that *the enterprise can be viewed from different aspects. In practice it is not possible to show all the aspects of an enterprise in one model. The model would be so complex that it would be impossible to handle and work with. Usually the model contains those aspects that are crucial for solving the problem.* Thus the model depends on the task it is used for.

The model is a simplified and abstracted version of something. The degree of abstraction and simplification depends on the interest of the targeted audience. Thus the model depends on the stakeholders of the scenario it was designed for.

To generalize, we can say that the degree of abstraction simplification, just like the points of view adopted, depends on the specifications of the system (computerized or not) exploiting the formal model, and therefore it ultimately depends on the stakeholders' expectation. That is why [Solberg, 2000], with reference to [Vernadat, 1996], insists on the fact *an enterprise model must have a finality and must provide added value to the enterprise. The finality is defined by the goal of modeler. Examples of such finalities are:*

- *to better represent and understand how the enterprise or some part(s) of it works*
- *to capitalize acquired knowledge and know-how for later reuse*
- *to rationalize and secure information flows*
- *to design or redesign and specify a part of the enterprise*
- *to analyze some aspects of the enterprise*
- *to simulate the behavior of some part(s) of the enterprise*
- *to make better decisions about enterprise operations and organization*
- *to control, co-ordinate, or monitor some parts of the enterprise*

Studying the actual state of the art of enterprise modeling one can notice that it is currently extensively used for enterprise design concerns. Examples of problems addressed by techniques using enterprise modeling are:

- enterprise development (see for example [Alfines, 2000])
- enterprise integration (see for example [Røstad, 2000])
- enterprise simulation (see for example [Szegheo and Martinsen, 2000])
- performance measurement (see for example [Deng, 2000])
- self-assessment (see for example [Fagerhaug, 2000])
- business process improvement (see for example [Andersen, 2000])
- setting-up extended enterprise (see for example [Szegheo and Petersen, 2000])

Therefore it is clear that *any kind of enterprise model serves a purpose. There are many different purposes but fundamentally any enterprise model aims to make people understand, communicate, develop, and cultivate solutions to business problems. (...) The difference between different enterprise models might lay in the purpose of the model, the content of the model, the quality of the formalism and manifestation, the level of abstraction, and the span of existence.* [Szegheo, 2000]

[Solberg, 2000] stresses that the objective of a model *is neither to fully describe all aspects of a manufacturing enterprise nor to model the entire enterprise. This would be useless, nearly impossible, and certainly endless as enterprises are tremendously complex systems in terms of number of entities involved, things to do, decision variables to be considered, and processes to be controlled.*

We can notice here that these conclusions have also been exposed in the ontology and knowledge engineering communities. It is simply logical, because ontologies are part of the modeling techniques, and as we saw before they are also designed with a given purpose in mind. Ontologies like TOVE [TOVE, 2000], or Enterprise Ontology [Uschold *et al.*, 1998] have developed, for instance, a view concerning the processes and workflow whereas in CoMMA we did not model those aspects since, so far, we do not exploit them in our scenarios. However our part on the document aspect (central to a documentary corporate memory) is much bigger and detailed than in TOVE or Enterprise ontologies.

So, so far, the enterprise modeling field has been mainly concerned with simulation and optimization of the production system design with relevant criteria called performance indicators. Such modeling aims at improving industrial competitiveness. It provides benchmark for business processes and is used for business process re-engineering.

As it is largely acknowledged in contemporary literature, 'globalization' and 'information society' modified the market rules of the game and set new constraints on its stakeholders. [Rolstadås, 2000] notices *there is an industrial change in direction of organizing work in projects. This change from operations management to project management involves that enterprises to a larger extent will handle their business as projects and use project planning and control tools rather than the classic operations management tools*. In fact this introduces the necessity of being able to create, manage and dissolve ephemeral teams when necessary to adapt the dynamic of market. One of the new stakes of this situation is to be able to capitalize

and reuse the knowledge from past project experiences when their structure (team) has dissolved in a new organization.

[Rolstadås, 2000] also identifies *a trend toward organizing work to use teams that are designed on an interdisciplinary basis. This enables things to be done more in parallel than earlier and thus reduces time to market. It also stimulates new innovation, often in the intersection between technology and social sciences*. This new trend leads to the problem of managing and integrating multiple expertise points of view in the design rationale and then in the corporate memory to enable the history of an older project to be revisited and to take advantage of this experience in new projects.

During the last decade, another trend has evolved which is the life cycle aspect. This takes environment and sustainability into account. Products must be made for the entire life cycle including scrapping, disassembly, or recycling. In production management this has created new challenges such as green logistics [Rolstadås, 2000]. The life cycle aspect also implies the transfer of information or knowledge from one stage to another (e.g.: from assembly to disassembly) and therefore it sets constraints on the documentation and more broadly the memory attached to one product.

We will conclude this part with a paradoxical aspect of modeling which arises as soon as a model has to be used by people that may not have been involved in its design or when the design is subject to a consensus. [Solberg, 2000], again with reference to [Vernadat, 1996], explained it perfectly:

Enterprise models are useful only if they are used. They will be accepted by users as a tool if they are simple to understand, easy to use, computer supported, and if they provide a realistic image of the reality. This explains the failure of many approaches proposed in the past, or the difficulty of proven sophisticated techniques to be accepted in practice, such as Petri nets.

The opposite side of the coin is that users are often looking for oversimplified techniques, which do not go far enough in details and at the end have little value. The difficulty for tool builders is to develop sophisticated modeling and analysis environments which hide this complexity and have a user-friendly interface, good graphical model representations, and 'talk' the language of the user while at the same time offering powerful analysis and simulation capabilities.

Ultimately, the success of an enterprise model depends on if it works appropriately, and the best way to find this out is to test it. Such a test will uncover how the enterprise model works.

4.5 Structuring the memory

So as we said in the first part, until now the enterprise modeling has been mainly used as a tool for enterprise engineering. But the new trends and the shift in the market rules led enterprises to become aware of the value of their memory and the fact that enterprise model has a role to play in this application too. [Rolstadås, 2000] notices that *enterprise models may well constitute a theoretical basis for the information system in an enterprise, and are by many regarded as a substantial opportunity to improve global competitiveness of industry.*

In CoMMA our goal is not to evaluate the model or optimize it to support enterprise evolution. The model we envisage aims at supporting corporate memory activities involved in the new employee scenario and the technology monitoring scenario. Our use of this *abstract representation of reality* is to enable the CoMMA system to get insight in the organizational context and environment and to intelligently exploit the aspect described in this model in its interaction with users.

Now as noticed by [Szegheo, 2000] the enterprise model, like any model, will have to be *expressed in terms of a language. The language could be formal or informal. The richest languages are natural languages, their use would seem logical. The problem is that they lack formalism and their interpretation is not universal. A good modeling language is formalized. Its usage and meaning is unambiguous.*

In CoMMA, the enterprise model aims at supporting corporate memory activities involved in the new employee scenario and the technology monitoring scenario. Our use of this explicit partial representation of reality is to enable the CoMMA system to get insight in the organizational context and environment and to intelligently exploit the aspects described in this model for the interaction between agents and overall between agents and users. Papazoglou and Heuvel [1999] explained that *it is necessary to have an understanding of the organizational environment, its goals and policies, so that the resulting systems will work effectively together with human agents to achieve a common objective.* Many formal languages exist to describe a model, see [Gastinger and Szegheo, 2000] for an overview of the enterprise modeling approaches. In CoMMA we decided to decouple the modeling language from the formalism by doing ontology-based modeling. The methodology IDEF5 in the beginning of the 90s proposed also to develop ontologies for the enterprise modeling. The modeling process in that case is split in two: (a) the design of an ontology that will

provide natural customized yet unambiguous vocabulary to express the models, (b) the implementation of the model using a formalism supporting our ontology. To benefit from the XML standard technology assets we decided to use the RDF Schema and RDF language to describe our ontology and implement our models (see RDF(S) description in a following section). This choice enables us to base our system on the W3C recommendations that benefit from all the web based technologies for networking, display and navigation, and this is an asset for the integration to a corporate intranet environment.

As we said, a corporate memory has a delimited and defined context, infrastructure and scope: the corporation. In the corporate context, we can more precisely identify the stakeholders (e.g.: information providers, information seekers); moreover the corporate community shares some common global views of the world (e.g.: company policy, best practices) and thus an ontological commitment is conceivable to a certain extent. Based on this ontology, we describe the organizational state of affairs including the enterprise structural model and the users' profile. The expression "state of affairs" was imported on purpose from the field of ontological engineering. It refers to the general state of things, the combination of circumstances at a given time, that will be subject to a description in the conceptual terms provided by the ontology. Figure 26 echoes the example of cubes given in Figure 1 .

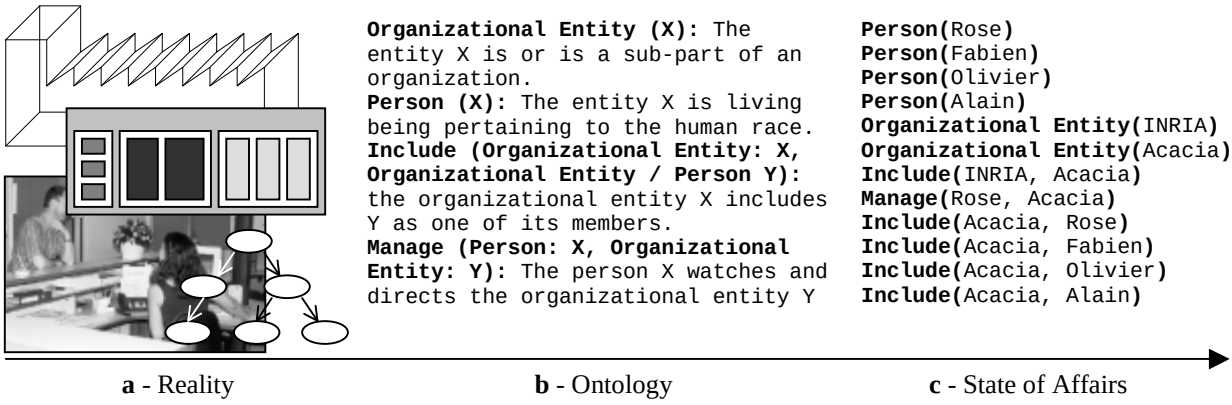


Figure 26 Reality, ontology and state of Affair in the context of an organizational memory

Likewise, the users' profile captures all aspects of the user identified as relevant for the system behavior. It contains administrative information and the user's preferences that were directly made explicit: such preferences can go from interface customization to topic interests. The user's profile also positions the user in the organization: role, location and potential acquaintance network. In addition to explicitly stated information, the CoMMA system will derive information from the usage made by the user. It will collect the history of visited documents and possible feedback from the user, as well as the user's recurrent queries, failed queries, and from this it can learn some of the user's habits and preferences. These derived criteria can then be used for interface purposes or push technology. Finally the profiles enable to compare users, to cluster them based on similarities in their profiles and then use the similar profiles to make suggestions (techniques of collaborative filtering).

The different stages of our approach are:

- We applied knowledge engineering techniques for data collection in order to provide the conceptual vocabulary detected as needed in the scenarios. We specified the corporate memory concepts and their relationships in an ontology (O'CoMMA) and we formalized the ontology in RDFS.
- We used the ontology and the results from data collection to propose enterprise and user models in order to describe the organizational State of affair. These models are implemented in RDF and instantiate the RDFS ontology description.
- We structure the corporate memory by writing RDF annotations on the documents: these annotations instantiate the RDFS ontology description and refer to the state of affair.

The ontology, the state of affairs and the annotations are tightly linked and evolve in a prototype life cycle style. The ontology and the state of affairs capture the modeling on which the inferences will be based.

The union of the ontology and the state of affairs forms the model. The archiving structure depends on both and that is why the memory is said to be a model-based information system.

Both the state of affairs and the annotations are instances of the RDFS schema and implemented as RDF annotations. That is why the Ontology is considered to be at the intensional level whereas the state of affairs and the annotations are at the extensional level.

All these aspects are summarized in the OSA schema shown in Figure 27.

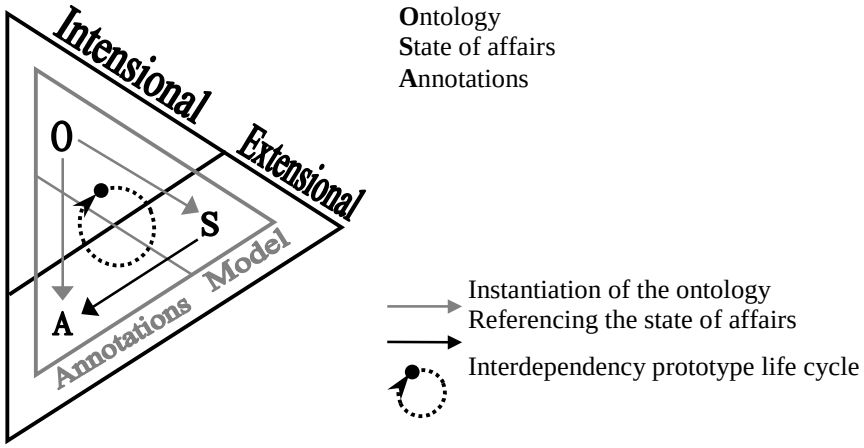


Figure 27 O.S.A: Ontology, State of Affairs and Annotations.

As this schema is may be quite synthetic, I usually develop it and comment it in a sequence of small illustrations as given in Table 2.

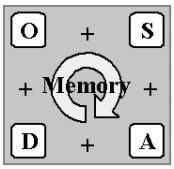
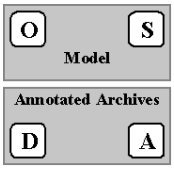
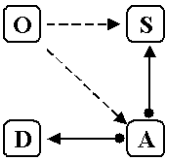
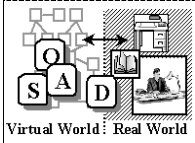
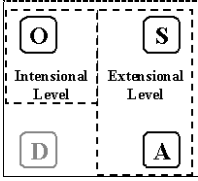
	The memory is composed of the **D**ocuments, their **A**nnotations, the **S**tate of Affairs (user profiles and organization model) and the **O**ntology. The whole follows a prototypical life-cycle, evolving and interacting with each other.
	The **O**ntology and the **S**tate of Affairs form the model on which is based the structuring of the memory. The archive structure relies on the **A**nnotations of the **D**ocumentary resources.
	The **A**nnotations and the **S**tate of Affairs are formalized using the conceptual vocabulary provided by the **O**ntology. The **A**nnotations reference the **D**ocuments (ex: report http://www...) and the objects of the **S**tate of Affair (ex: written by Mr. X for the division ABCD)
	The **O**ntology, the **A**nnotations and the **S**tate of Affairs form a virtual world capturing the aspects of the real world that are relevant for the system.
	The **O**ntology defines modeling and annotation primitives at the intensional level. The **S**tate of Affairs and the **A**nnotations instantiate these primitives describing models and annotation de memory at the extensional level.

Table 2 Commenting the Memory structure

Finally I tried to make a link with the triangle of meaning we introduced at the beginning. Figure 28 shows that the ontology provides the association of concept with a meaning and symbols of the representation symbolic system. And annotations express relations between the occurrences of these concepts using their associated symbol.

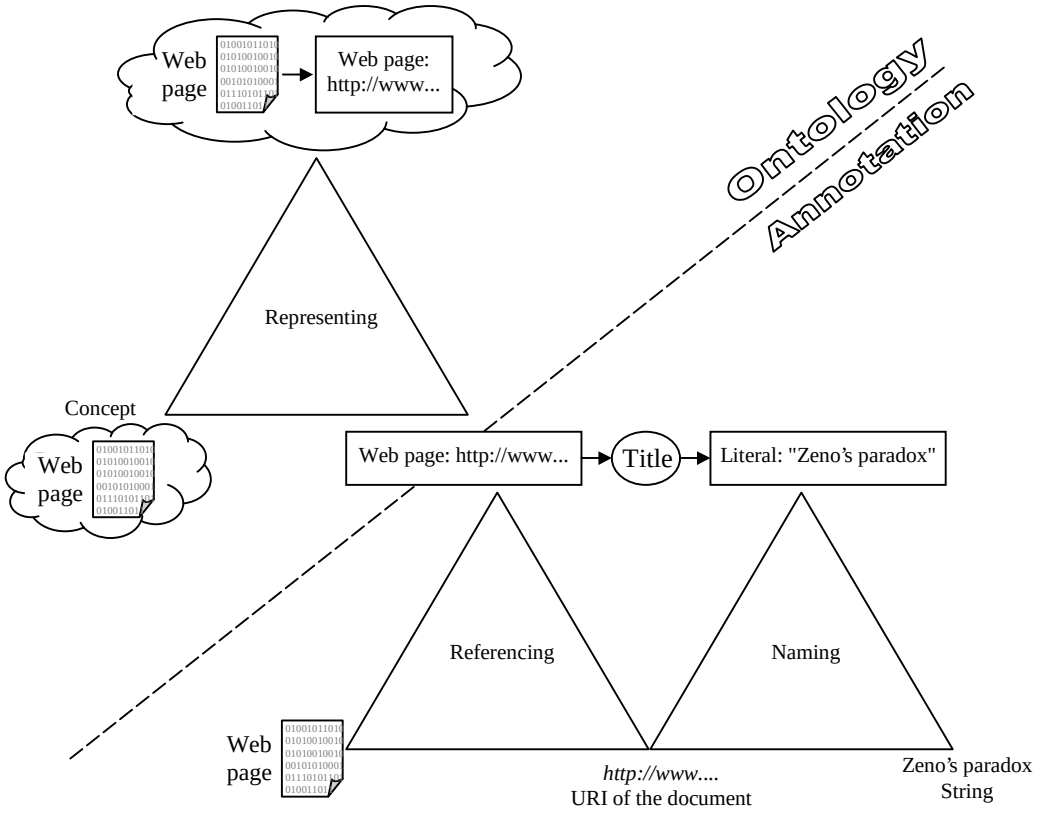


Figure 28 Link with the triangle of meaning

4.6 Implementation and technological choices

The CoMMA system is a MAS where agents have to manipulate and exploit document annotations and models as well as O'CoMMA ontology on which they are based. We detail here the implementation choices that gather the advantages of the XML technology and the Conceptual Graphs strong formal model and implementations.

4.6.1 XML: Metadata Approach

The eXtensible Markup Language (XML) is a description language recommended by the World Wide Web Consortium for creating and accessing structured data and documents in text format over internet-based networks. The XML syntax uses start and end tags to mark up information elements (for example <name> and </name> in Figure 29-a). Elements may be further enriched by attaching name-value pairs called attributes (for example, country="FR" in). Its simple syntax is easy to process by machine, and has the attraction of remaining understandable to humans. XML makes it possible to deliver information to agents in a form that allows automatic processing after receipt and therefore distribute the processing load over the MAS. It is also likely to become a *de facto* standard, and therefore a good candidate to exchange data and build a cooperation between heterogeneous and distributed sources which is exactly the type of problems tackled by multi-agent information systems adopting, for instance, the wrapper agents approach. XML is extensible: one can define new tags and attribute names to parameterize or semantically qualify data and documents. Structures can be nested to any level of complexity, so database schemas or object-oriented hierarchies can be represented.

Moreover, the set of elements, attributes, entities and notations that can be used within an XML document instance can optionally be formally defined in a document type definition (DTD) embedded, or referenced, within the document. The DTD gives the names of the elements and attributes, the allowed sequence and nesting of tags, the attribute values and their types and defaults, etc. The main reason to explicitly define the language is that documents can be checked to conform to it. Therefore once a template has been issued, one can establish a common format and check whether or not the documents placed in the corporate memory are valid. Figure 29-b presents a DTD corresponding to the XML example of Figure 29-a. Unfortunately the semantics of the tags cannot be described in a DTD. However if an agent knows the semantics, it can use the meta-data and infer from it to help the users of the corporate memory. The semantics must be shared to allow cooperation among the agents and unambiguous exchanges; ontologies are a keystone of multi-agent systems. By describing the meaning of the actual content, structure description will help an agent find relevant information and enable matchmaking between producer and consumer agents.

```
<contact_details>
 <name>INRIA-Sophia</name>
 <address country="FR">
  <street>2004 Route des Lucioles</street>
  <city>Sophia Antipolis</city>
  <postal>06902</postal>
 </address>
 <phone>04 92 38 77 00</phone>
</contact_details>
```

(a) - XML Sample

```
<!DOCTYPE contact_details [
 <!ELEMENT contact_details (name, address,
                                        phone)>
 <!ELEMENT name (#PCDATA)>
 <!ELEMENT address (street, city, postal)>
 <!ELEMENT phone (#PCDATA)>
 <!ELEMENT street (#PCDATA)>
 <!ELEMENT city (#PCDATA)>
 <!ELEMENT postal (#PCDATA)>
 <!ATTLIST address country CDATA #REQUIRED >
]>
```

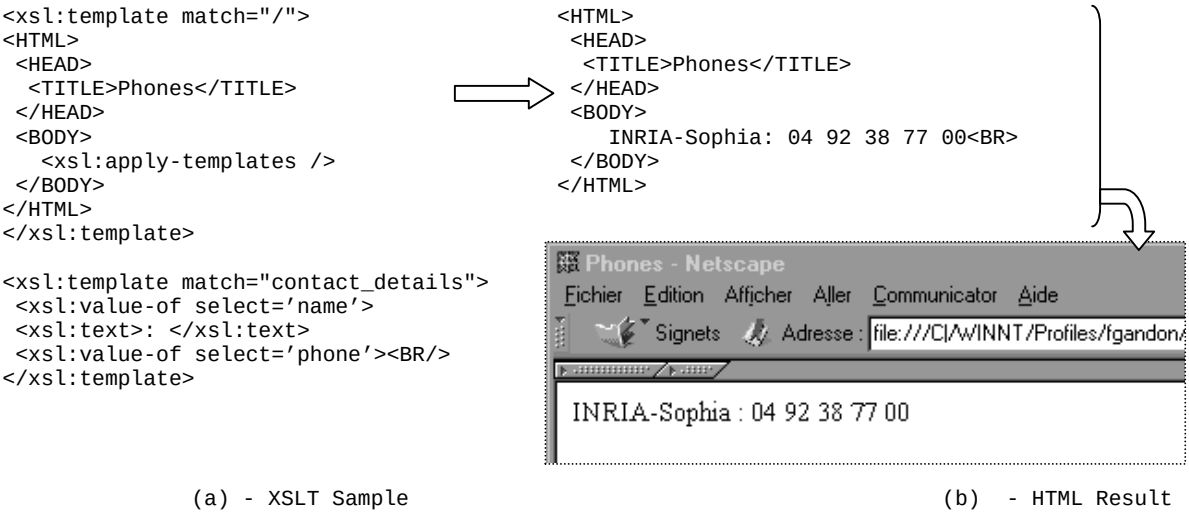
(b) - DTD Sample

Figure 29 XML and DTD Samples

XML Schema, a new recommendation of W3C is an XML language that should replace DTD. It does not enable us to describe semantics either, but it does allow to type documents and data.

Unlike HTML, XML tags describe the structure of the data, rather than the presentation. Content structure and display format are completely independent. The eXtensible Style sheet Language (XSL) can be used for expressing style sheets, which have document manipulation capabilities beyond styling. Thus a document of the corporate memory can be viewed differently and transformed into other documents so as to adapt to the need and the profile of the agents and the users while being stored and transferred in a unique format. Figure 30-a presents a style sheet extracting the name and the phone number from the document given in Figure 29-a. The output of this style sheet is an HTML file given in Figure 30-b. The ability to dissociate structure

content and presentation enables the corporate memory documents to be used and viewed in different ways by different human agents or software agents. Therefore XML has a lot of assets to materialize company documents



(a) - XSLT Sample (b) - HTML Result

Figure 30 XSLT style sheet sample and result

4.6.2 RDF(S): Annotation approach

4.6.2.1 Introduction

Historically SHOE [Luke and Heflin, 2000] was one of the first languages to merge ontologies and Web markup languages. It stands for Simple HTML Ontology Extension, and aims at using HTML tags to semantically annotate Web Pages, describe a taxonomy of concepts and Horn clauses rules.

The W3C now proposes an XML language as a core for Web resources annotations: RDF(S). This sections merges and summarizes the aspects of the specifications of RDF 1.0 and RDFS 1.0 available on the web site of the W3C at www.w3.org. RDF(S) is the language used for CoMMA. **The content given here makes extensive use and is essentially a recap of the aspects of the W3C RDF Syntax recommendation** [Lassila and Swick, 1999] **and RDFS Candidate Recommendation** [Brickley and Guha, 2000] that are relevant for CoMMA.

The World Wide Web was originally built for human consumption, and although everything on it is machine-readable, this data is not "machine-understandable". Because of that, it is very hard to automate anything on the Web, and because of the volume of information it is not possible to manage it manually. The solution proposed by the W3C is to use metadata to describe the data contained on the Web. Metadata is "data about data" (for example, a library catalog is metadata, since it describes publications) or specifically in the context of the Web metada is data describing Web resources. The distinction between "data" and "metadata" is not an absolute one; it is a distinction created primarily by a particular application, and many times the same resource will be interpreted in both ways simultaneously.

Tim Berners-Lee defines the Resource Description Framework (RDF) as providing "the necessary foundation and infrastructure to support the description and management of (Web) data." [Berners-Lee, 1999]. RDF is a foundation for processing metadata; it provides interoperability between applications that exchange machine-understandable information on the Web. RDF emphasizes facilities to enable automated processing of Web resources.

Among the variety of application areas RDF can be used for, three are of special interest to us here:

- resource discovery to provide better search engine capabilities
- cataloging for describing the content and content relationships available at a particular site or page by intelligent software agents to facilitate knowledge sharing and exchange,
- content rating

As a result of many communities coming together and agreeing on basic principles of metadata representation and transport, RDF has drawn influence from several different sources. The main influences have come from the Web standardization community itself in the form of HTML metadata and PICS, the library community, the structured document community in the form of SGML and more importantly XML,

and also the knowledge representation (KR) community. There are also other areas of technology that contributed to the RDF design; these include object-oriented programming and modeling languages, as well as databases. RDF can be characterized as a simple frame system that does not specify a mechanism for reasoning. A reasoning mechanism can be built on top of this frame system

The RDF recommendation introduces a model for representing RDF metadata as well as a syntax for encoding and transporting this metadata that uses XML. RDF and XML are complementary: RDF is a model of metadata and only addresses by reference many of the encoding issues that transportation and file storage require (such as internationalization, character sets, etc.). For these issues, RDF relies on the support of XML. It is also important to understand that this XML syntax is only one possible syntax for RDF and that alternate ways to represent the same RDF data model may emerge.

The broad goal of RDF is to define a mechanism for describing resources that makes no assumptions about a particular application domain, nor defines (a priori) the semantics of any application domain. The definition of the mechanism is domain neutral, yet the mechanism is suitable for describing information about a broad range of domains.

4.6.2.2 Basic RDF Model

The foundation of RDF is a model for representing named properties and property values. RDF properties are attributes of resources and in this sense correspond to traditional attribute-value pairs. RDF properties also represent relationships between resources and an RDF model can therefore resemble an entity-relationship diagram. In object-oriented design terminology, resources correspond to objects and properties correspond to instance variables. However properties, as we will see in RDFS, are defined outside the classes.

The basic data model thus consists of four object types:

- **Resources**: All things being described by RDF expressions are called resources. A resource may be an entire Web page; such as the HTML document "http://www.w3.org/Overview.html" for example. A resource may be a part of a Web page; e.g. a specific HTML or XML element within the document source. A resource may be an electronic document; e.g. an image, a ziped file, etc. A resource may also be a whole collection of pages; e.g. an entire Web site. A resource may also be an object that is not directly accessible via the Web; e.g. a printed book. Resources are always named by URIs plus optional anchor ids. Anything can have a URI; the extensibility of URIs allows the introduction of identifiers for any entity imaginable. This is important because we can reference legacy resources and even books. A legacy application is a program or a group of programs in which an organization has invested time and money and usually it cannot be changed or removed without considerable impact on the activity or the workflow. Just as an important feature of new software systems is the ability to integrate legacy systems, an important feature of a corporate memory management framework would be the ability to integrate the legacy archives, especially the existing working documents. Since RDF allows for external annotations, existing documents of the corporate memory may be kept intact (word processor document, spreadsheet, image, etc.) and annotated externally.
- **Properties**: A property is a specific aspect, characteristic, attribute, or relation used to describe a resource. Each property has a specific meaning, defines its permitted values, the types of resources it can describe, and its relationship with other properties. The RDF Schema specification addresses how the characteristics of properties are expressed.
- **Literal**: The most primitive value type represented in RDF, typically a string of characters. The content of a literal is not interpreted by RDF itself and may contain additional XML markup. Literals are distinguished from Resources in that the RDF model does not permit literals to be the subject of a statement.
- **Statements**: A specific resource together with a named property plus the value of that property for that resource is an RDF statement. These three individual parts of a statement are called, respectively, the subject, the predicate, and the object. The object of a statement (i.e., the property value) can be another resource or it can be a literal; i.e., a resource (specified by a URI) or a simple string or other primitive data type defined by XML. In RDF terms, a literal may have content that is XML markup but is not further evaluated by the RDF processor.

Thus the RDF data model is defined formally as follows:

1.There is a set called Resources.
2.There is a set called Literals.
3.There is a subset of Resources called Properties.
4.There is a set called Statements, each element of which is a triple of the form {*pred*, *sub*, *obj*}

Where *pred* is a property (member of Properties), *sub* is a resource (member of Resources), and *obj* is either a resource or a literal (member of Literals). The triple is the quantum of knowledge representation in RDF. We can view a set of statements (members of Statements) as a directed labeled graph: each resource and literal is a vertex; a triple {predicate, subject, object} is an arc from subject to object, labeled by predicate (see Figure 31).

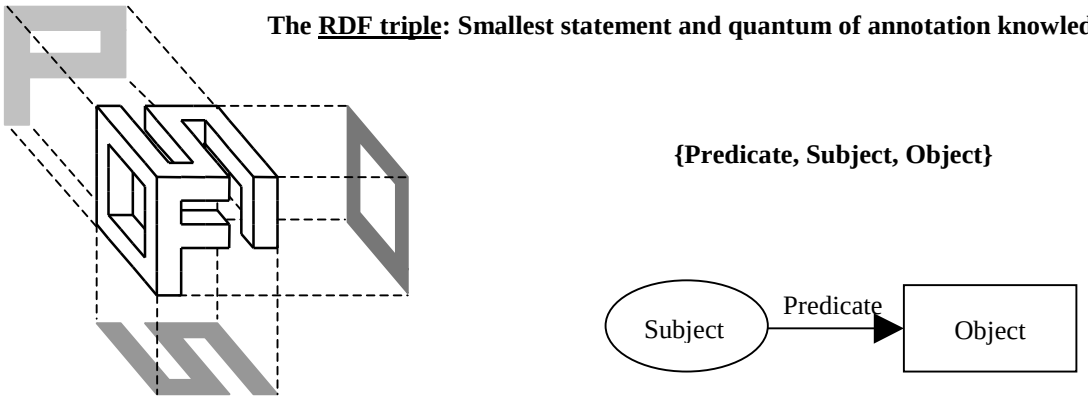


Figure 31 The RDF Triple

This can be read either	*object* is the value of *predicate* for *subject*
or (left to right)	*subject* has a property *predicate* with a value *object*
or even	the *predicate* of *subject* is *object*

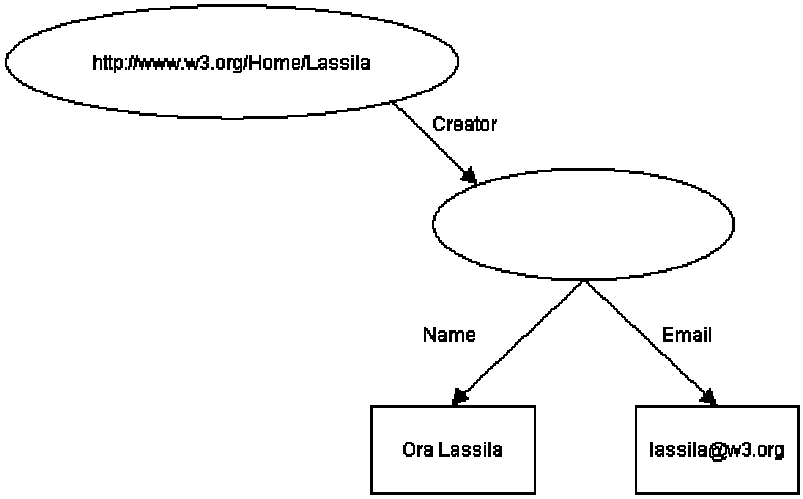
For instance, the fact that "Fabien Gandon" created his Web Page is represented in the ways in Figure 32.

{CreatedBy, http://www-sop.inria.fr/acacia/personnel/Fabien.Gandon/, "Fabien Gandon"}

```
<?xml version="1.0"?>
  <rdf:RDF
    xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
    xmlns:s="http://description.org/schema/">
    <rdf:Description about="http://www-sop.inria.fr/acacia/personnel/Fabien.Gandon/">
      <s:CreatedBy>Fabien Gandon</s:CreatedBy>
    </rdf:Description>
  </rdf:RDF>
```

Figure 32 Example of triplet

Thus the RDF data model intrinsically only supports binary relations; that is, a statement specifies a relation between two resources. Illustrating the problem of granularity or conceptualization we addressed before, the RDF recommendation gives the following example (see Figure 33) where one wants to be more precise saying that "The *individual* whose *name* is Ora Lassila, and *email* is <lassila@w3.org>, is the *creator* of http://www.w3.org/Home/Lassila".




```
<rdf:RDF>
  <rdf:Description about="http://www.w3.org/Home/Lassila">
    <s:Creator>
      <rdf:Description>
        <v:Name>Ora Lassila</v:Name>
        <v:Email>lassila@w3.org</v:Email>
      </rdf:Description>
    </s:Creator>
  </rdf:Description>
</rdf:RDF>
```

Figure 33 Annotation Example from RDF specifications

The property named "type" is defined to provide primitive typing. Thus continuing the formal definition:

5.There is an element of Properties known as RDF:type.

6.Members of Statements of the form {RDF:type, sub, obj} must satisfy the following: sub and obj are members of Resources. RDFS places additional restrictions on the use of type.

The RDF specification is complemented by the RDFS specification: to facilitate the definition of metadata, RDF has a class system much like many object-oriented programming and modeling systems.

4.6.2.3 RDFS

The meaning is crucial to understanding the statements and, in the case of applications of RDF, is crucial to establishing that the correct processing occurs as intended. It is crucial that both the writer and the reader of a statement understand the same meaning for the symbolic ID used, such as Creator, approvedBy, Copyright, etc. or confusion will result. Here we see the problematics of ontologies reappear again. The RDF data model, however, provides no mechanisms for declaring these properties, nor does it provide any mechanisms for defining the relationships between these properties and other resources. That is the role of RDF Schema

Resource description communities require the ability to say certain things about certain kinds of resources. For describing bibliographic resources, for example, descriptive attributes including "author", "title", and "subject" are common. For digital certification, attributes such as "checksum" and "authorization" are often required. The declaration of these properties (attributes) and their corresponding semantics are defined in the context of RDF as an RDF schema. RDFS does not specify a vocabulary of descriptive elements such as "author". Instead, it specifies the mechanisms needed to define such elements, to define the classes of resources they may be used with, to restrict possible combinations of classes and relationships, and to detect violations of those restrictions. Thus RDFS defines a schema specification language. More succinctly, **the RDF Schema mechanism provides a basic type system for use in RDF models. It defines resources and properties such as rdfs:Class and rdfs:subClassOf that are used in specifying application-specific schemas.**

Thus, a schema defines the properties of the resource (e.g., title, author, subject, size, color, etc.) and also defines the kinds of resources being described (books, Web pages, people, companies, etc.). A schema defines the concepts that will be used in RDF statements and gives their specific meanings. Classes and

Properties are organized in a hierarchy, and offer extensibility through subclass refinement. A schema is also the place where definitions and restrictions of usage for properties are documented.

In order to create a schema slightly different from an existing one, one can just provide incremental modifications to some existing base schema. In order to avoid confusion between independent and possibly conflicting definitions of the same concept ID, RDF uses the XML namespace facility. Namespaces are simply a way to tie a specific use of a concept ID in context to the schema where the intended definition is to be found. In RDF, each predicate used in a statement must be identified with exactly one namespace, or schema. However, a Description element may contain statements with predicates from many schemas. RDF uses the XML Namespace facility to identify the schema in which the properties and classes are defined. Since changing the logical structure of a schema risks breaking other RDF models which depend on that schema, the specification recommends that a new namespace URI should be declared whenever an RDF schema is changed. In effect, changing the RDF statements which constitute a schema creates a new one; new schema namespaces should have their own URI to avoid ambiguity. Since an RDF Schema URI unambiguously identifies a single version of a schema, software that uses or manages RDF (eg., caches) should be able to safely store copies of RDF schema models for an indefinite period. Since each RDF schema has its own unchanging URI, these can be used to construct unique URI references for the resources defined in a schema. This is achieved by combining the local identifier for a resource with the URI associated with that schema namespace.

Through the sharability of schemas, RDF supports the reusability of metadata definitions. Due to RDF's incremental extensibility, agents processing metadata should be able to trace the origins of schemata they are unfamiliar with back to known schemata and perform meaningful actions on metadata they weren't originally designed to process. The sharability and extensibility of RDF also allows metadata authors to use multiple inheritance to "mix" definitions, to provide multiple views to their data, leveraging work done by others. In addition, it is possible to create RDF instance data based on multiple schemata from multiple sources (i.e., "interleaving" different types of metadata). Schemas may themselves be written in RDF;

The typing system is specified in terms of the basic RDF data model - as resources and properties. Thus, the resources constituting this typing system become part of the RDF model of any description that uses them. The schema specification language is a declarative representation language influenced by ideas from knowledge representation (e.g., semantic nets, frames, predicate logic) as well as database schema specification languages (e.g. NIAM) and graph data models. The RDF schema specification language is less expressive, but much simpler to implement, than full predicate calculus languages.

RDF Schemas might be contrasted with XML Document Type Definitions (DTDs) and XML Schemas. Unlike an XML DTD or Schema, which gives specific constraints on the structure of an XML document, an RDF Schema provides information about the interpretation of the statements given in an RDF data model. While an XML Schema can be used to validate the syntax of an RDF/XML expression, a syntactic schema alone is not sufficient for RDF purposes. RDF Schemas may also specify constraints that should be followed by these data models. As RDF uses XML for its interchange encoding, the work on data typing in XML itself should be the foundation for such a capability.

The abstract RDF Schema core vocabulary can be used to make RDF statements defining and describing application-specific vocabularies such as the Dublin Core Element Set. The core schema vocabulary is defined in a namespace informally called 'rdfs' here, and identified by the URI reference http://www.w3.org/2000/01/rdf-schema#.

Resources may be instances of one or more classes; this is indicated with the rdf:type property. Classes themselves are often organized in a hierarchical fashion, for example a class Dog might be considered a subclass of Mammal which is a subclass of Animal, meaning that any resource which is of rdf:type Dog is also considered to be of rdf:type Animal.

The RDF Schema type system is similar to the type systems of object-oriented languages. However, RDF differs from many such systems in that instead of defining a class in terms of the properties its instances may have, an RDF schema will define properties in terms of the classes of resource to which they apply. This is the role of the rdfs:domain and rdfs:range constraints. For example, we could define the author property to have a domain of Book and a range of Literal, whereas a classical OO system might typically define a class Book with an attribute called author of type Literal. One benefit of the RDF property-centric approach is that it is very easy for anyone to say anything they want about existing resources, which is one of the architectural principles of the Web.

This figure Figure 34 uses a "nodes and arcs" graph representation of the RDF data model. If one class is a subset of another, then there is an rdfs:subClassOf arc from the node representing the first class to the node representing the second. Similarly, if a resource is an instance of a class, then there is an rdf:type arc from the resource to the node representing the class. The figure only shows the arcs to the most tightly encompassing class, and rely on the transitivity of the rdfs:subClassOf relation to provide the rest.

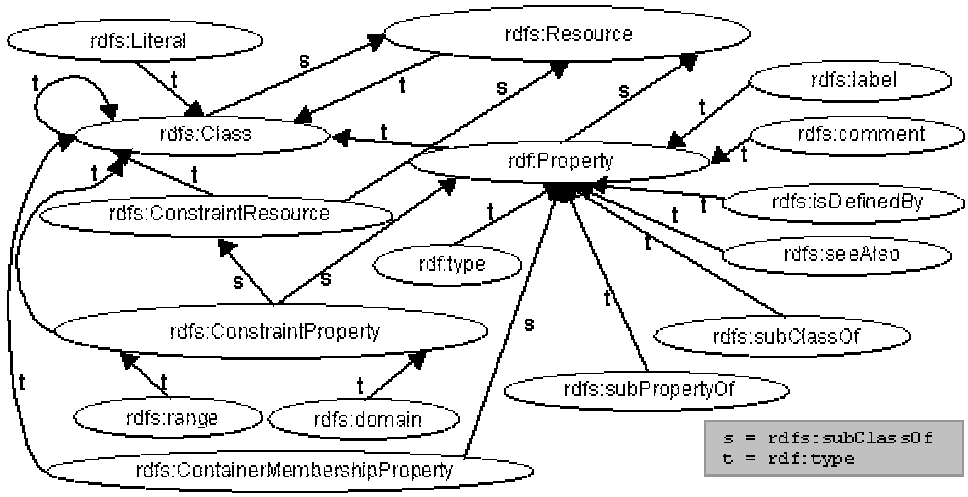


Figure 34 RDF Data model

RDF Schema provides a mechanism for describing properties signature constraints, but does not say whether or how an application must process the constraint information. For example, while an RDF schema can assert that an author property is used to indicate resources that are members of the class Person, it does not say whether or how an application should act in processing that class information. Different applications may use these constraints in different ways - e.g., a validator will look for errors, an interactive editor might suggest legal values, and a reasoning application might infer the class and then announce any inconsistencies.

RDF schemas can express constraints that relate vocabulary items from multiple independently developed schemas. Since URI references are used to identify classes and properties, it is possible to create new properties whose domain or range constraints reference classes defined in another namespace.

The following constraints are specified in RDFS: rdfs:domain and rdfs:range constraints on property usage, the rule that rdfs:subPropertyOf and rdfs:subClassOf properties should not form loops, plus any further constraints defined using the rdfs:ConstraintResource extensibility mechanism. Different applications may exhibit different behaviors when dealing with RDF constraints

Some examples of constraints include:

- That the value of a property should be a resource of a designated class. This is known as a range constraint. For example, a range constraint applying to the author property might express that the value of an author property must be a resource of class Person.
- That a property may be used on resources of a certain class. This is known as a domain constraint. For example, that the author property could only originate from a resource that was an instance of class Book.

The RDF Schema specification builds upon the foundations provided by XML and by the RDF Model and Syntax. It provides some additional facilities to support the evolution both of individual RDF vocabularies, and of the core RDF Schema specification vocabulary introduced in this document.

The Resource Description Framework is intended to be flexible and easily extensible; this suggests that a great variety of schemas will be created and that new and improved versions of these schemas will be a common occurrence on the Web.

There are many scenarios for which these simple mechanisms are not adequate; a more comprehensive schema mapping mechanism for RDF are being developed in W3C Workgroups.

Finally, the following properties are provided to support simple documentation and user-interface related annotations within RDF schemas. Multilingual documentation of schemas is supported at the syntactic level through use of the xml:lang language tagging facility. Since RDF schemas are expressed within the RDF data model, vocabularies defined in other namespaces may be used to provide richer documentation.

rdfs:comment: This is used to provide a human-readable description of a resource.

rdfs:label: This is used to provide a human-readable version of a resource name.

These properties are used in CoMMA to capture natural language terms and definitions attached to concepts intensions. A toy example resuming the ideas beyond the use of RDF(S) to formalize a hierarchy of concepts and relations is given in Figure 35. It does not respect perfectly the syntax (namescapes and so on) but gives the flavor of the use of RDF(S) in CoMMA ; it asserts that 'Fabien Gandon' is the reviewer of a given article using a small schema.

```
<Class ID="Document"/>

<Class ID="Article">
  <subClassOf resource="#Document"/>
</Class>

<Property ID="reviewer">
  <domain resource="#Document"/>
  <range resource="#Literal"/>
</Property>
```

(a) Simplified sample of schema

```
<Article about="MyArticle.ps">
  <reviewer>Fabien Gandon</reviewer>
</Article>
```

(b) Simplified example of annotation

Figure 35 Toy example summarizing the use of RDF(S)

The annotations of CoMMA are based on the O'CoMMA ontology and this ontology is described and shared thanks to RDF Schema (CoMMA Shema is given in annex).

4.6.3 CORESES: Mapping between Conceptual Graphs and RDF(S)

As we have seen in the very first section, traditional IR search engines are limited to terms denoting the *extensional* aspect of concepts. The introduction of ontologies frees us from this restriction and enables us to reason at the *intensional* level. In order to infer over annotation bases, ACACIA developed CORESE [Corby *et al.*, 2000], a prototype of a search engine enabling inferences on RDF annotations by translating the RDF triples to Conceptual Graphs (CGs) and vice versa. The architecture of CORESE is given in Figure 36. Although it is presented as a client-server application, CORESE offers an API enabling us in CoMMA to include RDF(S) manipulation capabilities in agents.

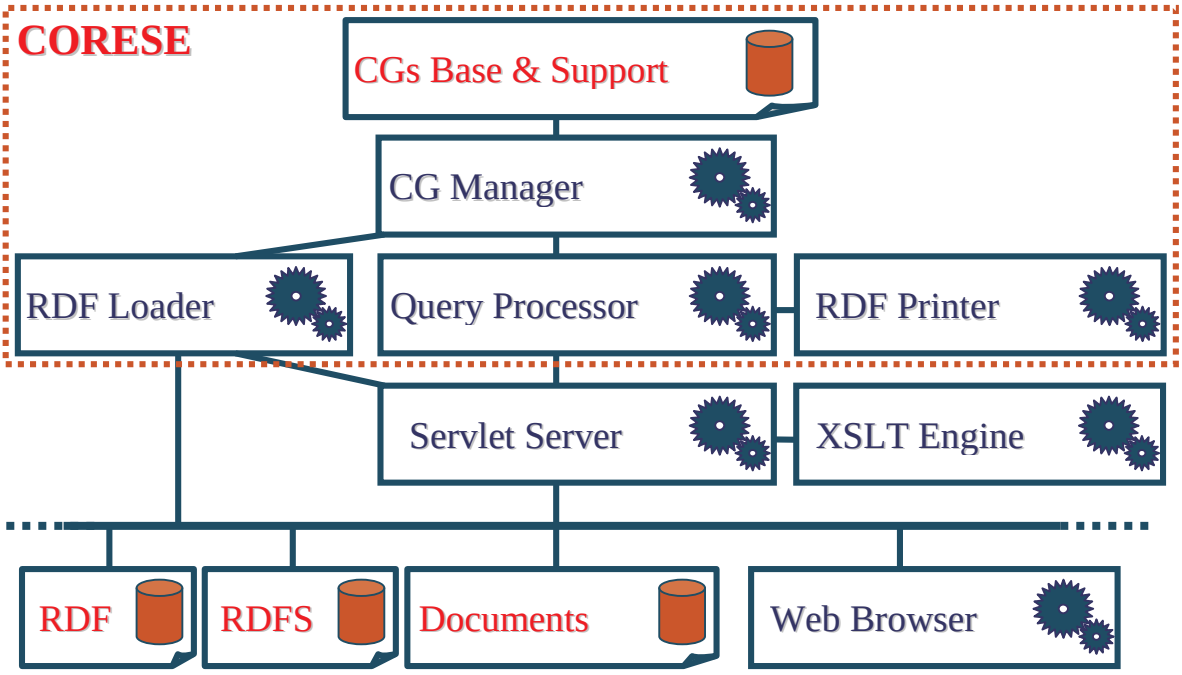


Figure 36 Architecture of CORESE.

CORESE combines the advantages of using the standard RDF language for expressing and exchanging metadata, and the query and inference mechanisms available in CG formalism [Sowa, 1984; Shein, 1992]. Among Artificial Intelligence knowledge representation formalisms, CGs are widely appreciated for being based on a strong formal model and for providing a powerful means of expression and very good readability. Moreover, inference and query mechanisms have been developed and tested, and are available to manipulate CGs. There exists a real adequacy between the two models: RDFS classes and properties smoothly map onto CG concept types and relation types Figure 37. More precisely, RDF statements are mapped to a base of CG facts, the class hierarchy defined in an RDF schema is mapped to a concept type hierarchy in the CG formalism and the hierarchy of properties described in the RDF schema is mapped to a relation type hierarchy in CG. The concept type hierarchy and the relation type hierarchy constitute what is called a support in the CG formalism: they define the conceptual vocabulary to be used in the CGs for the considered application.

In CORESE, queries are RDF statements with wildcard characters to describe the pattern to be found and the values to be returned. The RDF query is translated into a CG which is projected onto the CG base to isolate any matching graph and extract the requested values that are then translated back into RDF. The projection mechanism takes into account the hierarchies and specialization relations described by the CG support obtained from the RDF schemas. It also allows for tuning the matching processes, enabling approximate matching or generalization. We are currently investigating the development of a complete query language based on RDF and its mapping to CG projection. Other ongoing work is the extension of the functionalities previously developed for the engine in order to implement agent behaviors related to archiving and searching the documents in the corporate memory. Figure 38 presents examples of RDF and corresponding mapping to CGs.

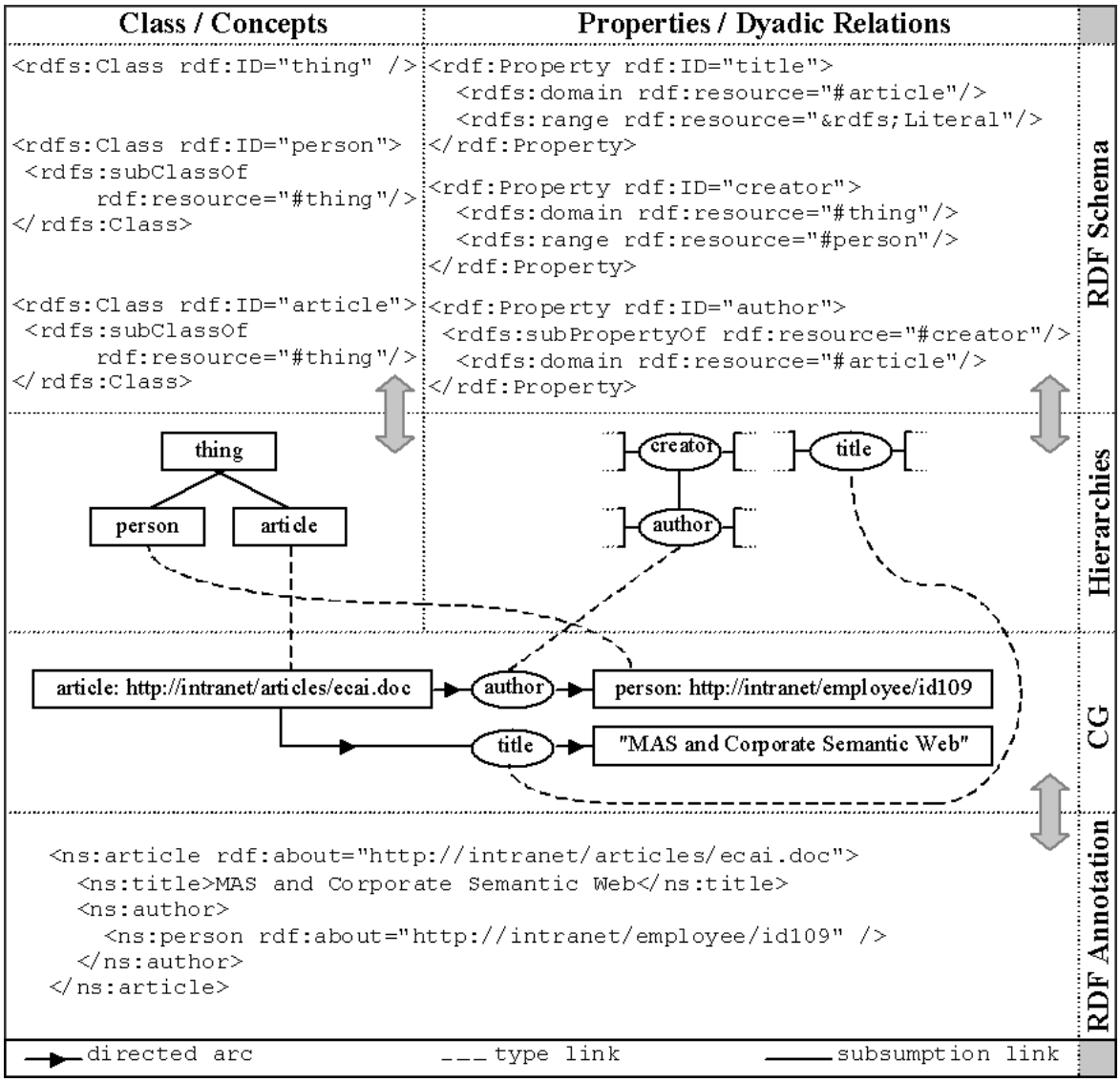


Figure 37 Mapping RDF(S) to Conceptual graphs

RDF Schema example:

```
<rdfs:Class rdf:ID='document'/>

<rdfs:Class rdf:ID='financial_report'>
 <rdfs:subClassOf rdf:resource='#document'/>
</rdfs:Class>

<rdf:Property ID='title'>
 <rdfs:domain rdf:resource='#document/>
 <rdfs:range rdf:resource='http://www.w3.org/TR/1999/PR-rdf-schema-19990303#Literal'/>
</rdf:Property>

<rdf:Property ID='author'>
 <rdfs:domain rdf:resource='#document'/>
 <rdfs:range rdf:resource='http://www.w3.org/TR/1999/PR-rdf-schema-19990303#Literal'/>
</rdf:Property>

<rdf:Property ID='finance_controller'>
 <rdfs:domain rdf:resource='#financial_report'/>
 <rdfs:range rdf:resource='http://www.w3.org/TR/1999/PR-rdf-schema-19990303#Literal'/>
</rdf:Property>
```

Translated into a conceptual graph support:

```
concept type document < Resource
concept type financial_report < document
relation type title (Document, Literal)
relation type author (Document, Literal)
relation type financial_report (financial_report, Literal)
```

An RDF annotation using the schema:

```
<rdf:RDF xmlns:rdf='http://www.w3.org/1999/02/22-rdf-syntax-ns#'
         xmlns:ns='http://www.inria.fr/acacia/FinanceSchema#'>
 <ns:financial_report rdf:about='http://intranet.mycompany.net/~finance/reportB078.doc'>
  <ns:author>Jeremy Smith</ns:author>
  <ns:title>STI Project</ns:title>
  <ns:finance_controller>Steven Clarck</ns:finance_controller>
 </ns:financial_report>
</rdf:RDF>
```

Translated into a conceptual graph:

```
[financial_report: http://intranet.mycompany.net/~finance/reportB078.doc] - {
 -> (author) -> [Literal: Jeremy Smith]
 -> (title) -> [Literal: STI Project]
 -> (finance_controller) -> [Literal: Steven Clarck] }
```

Figure 38 An example of translation from RDF to conceptual graph

4.7 On the importance of the ontology in this approach

Ontologies are a keystone of the CoMMA system since they provide the building blocks for models, annotations and agent messages, with their associated semantics. Actual keyword-based search engines such as the ones used for web searching are limited to the terminological and extensional aspect of concepts, the introduction of ontologies frees us from this restriction by enabling agents to reason at the intensional level.

We saw that the ontology-based approach was motivated by needs and observations that arose in both scenarios. The ontology can thus play 3 roles in the CoMMA system:

- First, the ontology is a key component of the corporate memory that captures a knowledge about the company, the domain... that may be useful, for instance, to a new employee trying to familiarize himself with the organization terms and policies.
- Second, it is central to multi-agents systems where agents need to rely on a shared conceptual vocabulary to express and understand the messages they exchange. In both scenarios, the agents must be able to understand each other in order to cooperate and assist the different users properly.
- Finally, in the information management system, queries and annotations on documents are expressed in a consensual vocabulary so that they can be matched. In both scenarios, the heterogeneous documents are manipulated thanks to their semantic annotations and extracted by queries; the annotations and queries being based on the same shared ontology.

In CoMMA the models we envisage (organizational state of affair and user profiles) aim at porting corporate activities enabling the system to get insight in the organizational context of its use. Based on these descriptions, the system will adopt its behavior to his environment. Supporting both scenarios and adapting to their different actors.

In CoMMA we developed only one ontology: agents and users will exploit different aspects of the same ontology. In the next section, we describe the process of engineering O'CoMMA (ontology of CoMMA).

Chapter 5 : RETURN ON EXPERIENCE IN ENGINEERING O'COMMA

O'CoMMA has been influenced by the return on experience and the analysis on TOVE and the Enterprise Ontology done by Uschold and Gruninger [1996], the comparison and elements of methodology presented in [Fernandez *et al.*, 1997] and [Gómez-Pérez *et al.*, 1996] and the seminal work done on theoretical foundations of ontologies by Bachimont [2000], Guarino and Welty [Guarino, 1992; Guarino and Welty, 2000]. In the following parts, we present our approach, the first elements of our return on experience, and our expectations for the evolution of the ontology engineering field.

5.1 Position and definitions adopted for O'CoMMA

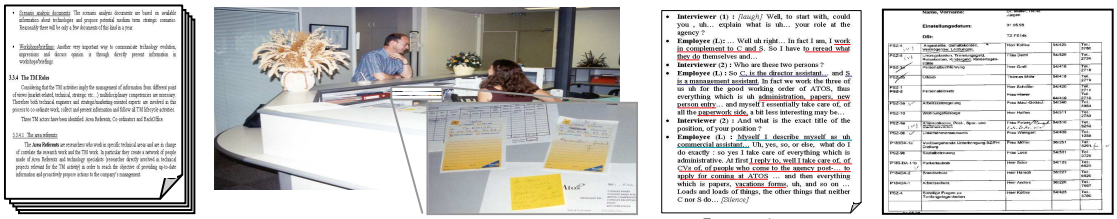
Before we go any further, we will state the definitions and the points of view adopted in the CoMMA project. The system exploits an organizational state of affairs, that is a system-relevant description of the general state of things and the combination of circumstances in an organization. To do so, we rely on an ontology to define the primitives required for the representation and to provide their semantics. Guarino and Giaretta [1995] defined an ontology as "a logical theory which gives an explicit, partial account of a conceptualization", the conceptualization being defined as "an intensional semantic structure which encodes the implicit rules constraining the structure of a piece of reality". The ontology is a partial explicit representation because it focuses on those aspects of the conceptualization that are critical for the behavior of the application.

A concept is a constituent of thought formed in mind (an idea, a notion, a principle) and which can be semantically valued and redeployed. The set of attributes characterizing a concept is called its intension and the collection of things represented by the concept is called its extension. There exists a duality between intension and extension: to included intensions $I_1 \supset I_2$ correspond included extensions $E_1 \subset E_2$. An intension is determined by identifying the qualitative or functional properties shared by all the entities represented by the concept. The set of characteristics provides a definition. In order to express and communicate an intension we choose a symbolic representation e.g. the different notions associated to a term and given by a dictionary. Note that exemplification and illustration used in dictionaries show that it is sometimes necessary to clarify a definition in natural language, in order to produce a representative sample of the extension (i.e. examples) or to use other means of representation.

The representations of intensions can be organized, structured and constrained to express a logical theory accounting for relations existing between concepts. An ontology is an object capturing the expressions of intensions and the theory accounting for the aspects of reality selected for their relevance in the envisaged application scenarios. The representation of the intensions and the ontological structure can make use of more or less formal languages, depending on the intended use of the ontology. The formal expression of an intension provides a precise and unambiguous representation of the meaning of a concept, and it allows to manipulate it in a software and use it as a primitive for knowledge representation, models and annotations. Since the expression of an intension nearly always starts from a natural language definition, "defining an ontology is a modeling task based on the linguistic expression of knowledge" [Bachimont, 2000]. Through iterative refinements, we augment the ontology, developing the formal counter parts of semantic aspects relevant for the system in the application scenarios. In the ontology, concepts in intension are usually organized in a taxonomy, that is, a classification based on their similarities.

When a group of persons agree on the use and the theory specified in the ontology, they make an ontological commitment. Ontology engineering deals with the practical aspects, essentially methodologies and tools, of applying results from the Ontology theory, in order to build ontologies needed in a specific context and for a specific purpose.

(a) Scenarios and Data-collection



Scenarios | Observations | Interviews | Documents

(b) From semi-informal to semi-formal

Relation	Domain	Range	View	Super Relation	Other Terms	Natural Language Definition	Sy	Tr	Re	Pr
Manage	Organizational Entity;	Organizational Entity;	Organization	Relation	;	Relation denoting that an Organizational Entity (Domain) is in charge/control of another		Tr		EO
Created By	Document;	Organizational Entity; Person;	*;	Relation						

Attribute	Domain	Range Type	View	Super Relation	Other Terms	Natural Language Definition	Pr
Designation	Thing;	literal (string)	*;	;	;	Identifying word or words by which a thing is called and classified or distinguished from others	Us
Family Name	Person;	literal (string)	Person;	Designation;	Last Name; Surname	The name used to identify the members of a family	Us
					;	Mobile phone number	Us
				ation;	;	Name of a document	Us

Class	View	Super class	Other Terms	Natural Language Definition	Pr
Thing	Top-Level;	;	;	Whatever exists animate, inanimate or abstraction.	Us
Event	Top-Level; Event;	Thing;	;	**Thing** taking place, happening, occurring; usually recognized as important, significant or unusual	Us

(c) Formalizing in RDFS

```
<rdfs:Class rdf:ID="Dictionary">
 <rdfs:subClassOf
rdf:resource="#ReferenceDocument"/>
 <rdfs:comment xml:lang="en">Reference Document in which words are
listed alphabetically and their meanings</rdfs:comment>
 <rdfs:label xml:lang="en">Dictionary</rdfs:label>
</rdfs:Class>
```

(d) Navigation and Use

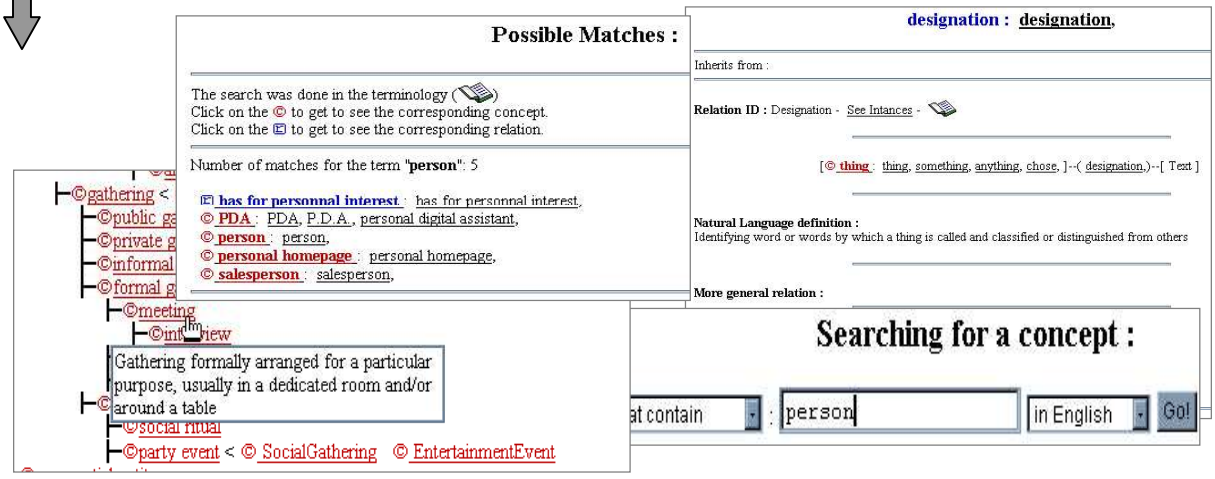


Figure 39 Snapshot of the ontology engineering process

5.2 Scenario analysis and Data collection

Several techniques exist for data collection that feeds the whole modeling process. We essentially used three of these techniques: semi-structured interview, observation and document analysis coupling them with an analysis phase based on scenarios (see Figure 39 - a).

5.2.1 Scenario-based analysis

Scenarios are textual descriptions of the organizational activities and interactions concerning the intended application. Following Caroll [1997] we used scenarios to capture in a natural and efficient way the end-users' needs in their context. This is vital for a symbiotic integration of the system in the work environment. In CoMMA, we chose to focus on two scenarios:

- New employee integration (how can we accelerate and facilitate the integration of a new employee in the company?)
- Technology monitoring support (how can we support the task of identifying, annotating and broadcasting relevant technological news in a company?)

The main advantages we recognized when using scenarios for CoMMA were:

- Scenarios enabled us to focus on the specific aspects of knowledge management involved in our case.
- They helped us capture the whole picture and they enabled us to view the system as a component of a possible knowledge management solution for a company.
- They represented a concrete set of interaction sequences with the corporate memory, understandable and accessible to all the stakeholders. They were a perfect start to build formal use cases and interaction diagrams.
- They provided a framework to check up on every new idea, every contribution.

Scenario analysis led us to define a table (c.f. Table 3) suggesting key aspects to be considered when describing a scenario. It provided suggestions as for what are the aspects to be investigated, what to look for and what could be refined when describing a scenario. It helped us define the scope of our intervention and thus the scope of the ontology: the conceptual vocabulary had to provide the expressiveness required by the interactions, between the system and its environment, described in the scenarios.

Characteristics	**Representation**	**Facets**	
Goal Scenario Before / Scenario After Scope Scenario / Sub-Scenario Generic / Specific Example, Illustration Relevance life-time Exceptions Counter examples	Textual Graphical Informal Formal (UML) **NB:** In one scenario description, several types of representations may be used.	Actors	Profile Role Individual goal Task Action Interaction
		Resources	Nature Services Constraints
		Logical & Chronological	Processes Decomposition Sequential / Parallel /Non deterministic Loops & Stop conditions Alternatives & Switches Compulsory / Optional
		Flows	Inputs Outputs Paths
		Functionalities & Rationale	Functionalities description Motivation, necessity Advantages & Disadvantages
		Environment	Internal Organization Acquaintance External

Table 3 Scenario template table

The table gives different aspects to be mentioned or looked for during data collection but it is neither a list of compulsory fields to be populated, nor a restrictive list, and it must not become a bias. It is a starting point to initialize and support data collection, avoiding an excessively free, unstructured and unfocused collection leading to information overflow and irrelevance. This table reduces the chances of missing some important aspects of the scenario.

Scenario analysis produced traces: in our case, scenario reports. As illustrated in the sample given in Figure 40, these reports are extremely rich story-telling documents and so, they are good candidates to be included in the corpus of a terminological study and therefore they were our first step in data collection.

- Scenario analysis documents: The scenario analysis documents are based on available information about technologies and propose potential medium term strategic scenarios. Reasonably there will be only a few documents of this kind in a year.

- Workshops/briefings: Another very important way to communicate technology evolution, impressions and discuss opinion is through directly present information in workshops/briefings.

3.3.4 The TM Roles

Considering that the TM activities imply the management of information from different point of views (market-related, technical, strategic etc…) multidisciplinary competencies are necessary. Therefore both technical engineers and strategic/marketing-oriented experts are involved in this process to co-ordinate work, collect and present information and follow all TM lifecycle activities.

Three TM actors have been identified: Area Referents, Co-ordinators and BackOffice.

3.3.4.1 The area referents:

The **Area Referents** are researchers who work in specific technical areas and are in charge of correlate the research work and the TM work. In particular they create a network of people made of Area Referents and technology specialists (researcher directly involved in technical projects relevant for the TM activity) in order to reach the objective of providing up-to-date information and proactively propose actions to the company's management.

Figure 40 Sample of scenario report.

In Figure 40, we underlined with dot lines the candidate terms interesting for modeling. As a toy example, we could deduce from this passage that three technology monitoring roles were identified and a partial sub-tree could be generated as in the toy example of Figure 41.

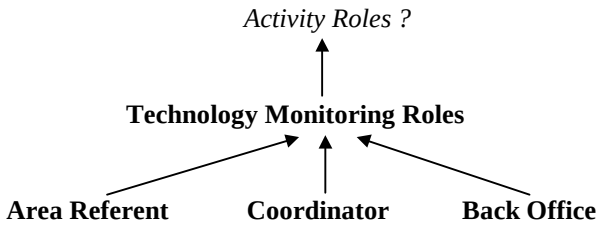


Figure 41 Toy example of a taxonomy of concepts

Obviously, consistency checks with the modeling point of view adopted and the existing work on the ontology should be carried out to refine and then plug this extension to the rest of the taxonomy. This addition is typically in a bottom-up perspective, and as we said, completeness and coherence require to trigger new tasks in the other perspectives (top-down and bottom-up) e.g.: is this list of TM Role complete? Does the role core concept exist? are there ontologies dealing with that subject?...).

5.2.2 Semi-structured interviews

Semi-structured interviews were carried out in three steps:

- A free opening discussion where the dialog was initiated with broad questions concerning the tasks and roles of the people interviewed. If needed this spontaneous expression could be kept running using short questions.
- Flashbacks and clarifications on specific questions prepared before the interview.
- A self-synthesis in order to make interviewees synthesize, summarize and analyze themselves what they said and make them conclude. The generalization and grouping they performed in this last part were especially interesting for the ontology structuring.

- **Interviewer (1) :** *[laugh]* Well, to start with, could you , uh… explain what is uh… your role at the agency ?
- **Employee (L):** … Well uh right… In fact I am, I work in complement to C and S. So I have to reread what they do themselves and…
- **Interviewer (2) :** Who are these two persons ?
- **Employee (L) :** So C, is the director assistant… and S is a management assistant. In fact we work the three of us uh for the good working order of ATOS, thus everything which is uh administration, papers, new person entry… and myself I essentially take care of, of all the paperwork side, a bit less interesting may be…
- **Interviewer (2) :** And what is the exact title of the position, of your position ?
- **Employee (L) :** Myself I describe myself as uh commercial assistant… Uh, yes, so, or else, what do I do exactly : so yes I take care of everything which is administrative. At first I reply to, well I take care of, of CVs of, of people who come to the agency post-… to apply for coming at ATOS … and then everything which is papers, vacations forms, uh, and so on … Loads and loads of things, the other things that neither C nor S do… *[Silence]*

Figure 42 Extract from an interview

We carried out an interview with a newcomer at ATOS (an industrial partner of the consortium). Figure 42 is extracted from this interview retranscribed and analyzed by Alain Giboin. From our point of view, we can find here interesting information about documents manipulated (e.g.: vacation forms), their use and the tasks they are linked to (e.g. to issue an order). During the interview, we also discussed the importance of the acquaintance network in her day-to-day activity and derived from this the importance of the organizational model.

During an interview, we can also detect specificity aspects that will have repercussions on the whole system specifications e.g.: the role described by the interviewee -commercial assistant- is different from the official role -secretary. Since the definition this newcomer had of her role and position was different from what was stated in the official organization chart, it is important to have and exploit user profiles in the CoMMA solution in addition to the enterprise model, to allow the system to adapt to the specificity of every user. The characteristics of these profiles have to be captured and this places a new requirement on the ontology.

The two major problems with this sort of collection and analysis is that it is time consuming and it is prone to overload designers with details.

5.2.3 Workspace observations

Another data-collection technique we applied was the *observation*. The observation can be about people, the way they work (with or without letting them comment their activity), on a real task or on a simulated scenario, in real time, recorded or based upon traces of the activity. It could also be focused on chosen indicators (documents manipulated, desk organization…). Depending on the actor and the scenario the interesting situation may be very different (a newcomer looking for information, a mentor explaining a technology, an observer commenting…).

We observed the desk of the newcomer we interviewed, as a lot of documents in the company go through her since she is an assistant. Figure 43 shows four pictures of her working place.

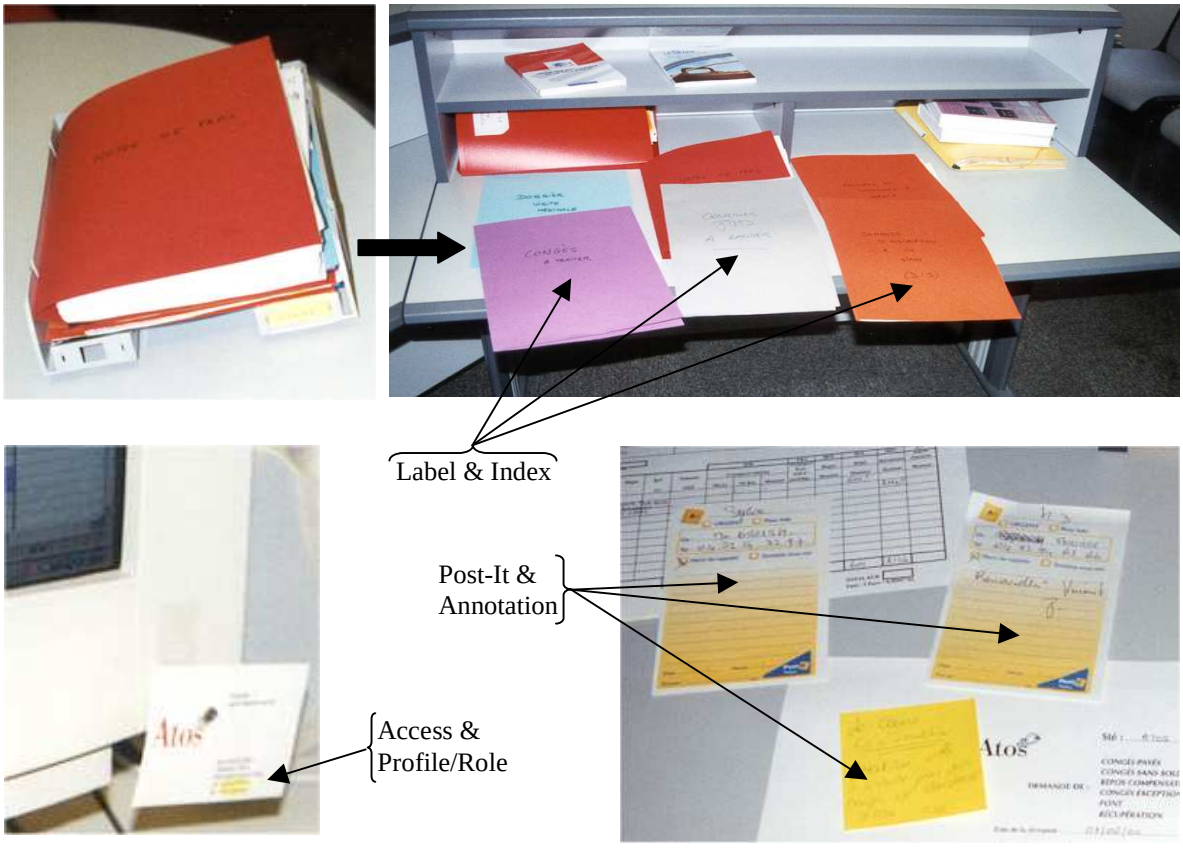


Figure 43 Observing working documents

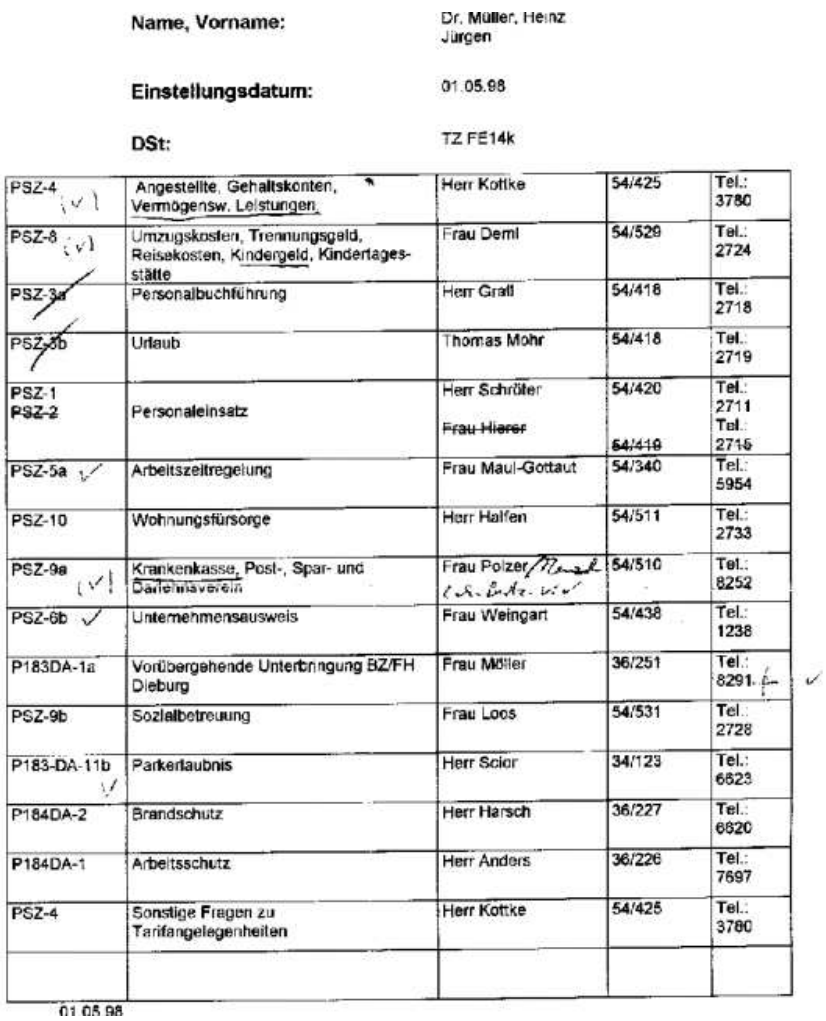
Observations reveal, that she was using two criteria to label the files: the type of documents (e.g.: vacation forms) and the process to be done on these documents (e.g.: to be signed). Another observation shows different types and use of annotations on documents using post-it's (targeted people, deadline, how to fill and use a form). Finally we also noticed that there are documents (in our case the company name card with the phone number and the fax number) that she does not want to sort, and put away with others (phone book, address book). Because of her activity, she wants to access it at the first glance when needed; in a system this would mean the ability to index/bookmark some documents so as to access them 'at the first click'.

These observations helped us understand what type of vocabulary was needed for the annotations, but not all the observations are relevant for scenarios or lead to feasible specifications. Once again great care has to be taken to focus on the scenario specific and relevant aspects during data-collection.

5.2.4 Document Analysis

The last type of data-collection techniques we used is the *document collection and analysis*. The gathering of typical documents is vital for a project that focuses on information retrieval in a corporate documentary memory. The purpose is to systematically collect documents involved in and relevant for the considered scenarios: lexicon, terminology, reports, graphical documents (forms, organization charts...), etc. A good practice is to collect both empty and filled forms so as to see their use, and also to 'follow a document' to its track in the organization.

An example is the new employee route card of T-Nova (Figure 44): it describes what to do, where to go, who is the contact, how to contact the person, and what is the order of the tasks to be carried out by a new employee once arrived.



Name, Vorname: Dr. Müller, Heinz Jürgen

Einstellungsdatum: 01.05.98

DSt: TZ FE14k

PSZ-4	Angestellte, Gehaltskonten, Vermögensw. Leistungen	Herr Kottke	54/425	Tel.: 3780
PSZ-8	Umzugskosten, Trennungsgeld, Reisekosten, Kindergeld, Kindertagesstätte	Frau Deml	54/529	Tel.: 2724
PSZ-3a	Personalbuchführung	Herr Grall	54/418	Tel.: 2718
PSZ-3b	Urlaub	Thomas Mohr	54/418	Tel.: 2719
PSZ-1 ~~PSZ-2~~	Personaleinsatz	Herr Schröter ~~Frau Hierer~~	54/420 ~~54/419~~	Tel.: 2711 Tel.: 2715
PSZ-5a	Arbeitszeitregelung	Frau Maul-Gottaut	54/340	Tel.: 5954
PSZ-10	Wohnungsfürsorge	Herr Halfen	54/511	Tel.: 2733
PSZ-9a	Krankenkasse, Post-, Spar- und Darlehnsverein	Frau Polzer	54/510	Tel.: 8252
PSZ-6b	Unternehmensausweis	Frau Weingart	54/438	Tel.: 1238
P183DA-1a	Vorübergehende Unterbringung BZ/FH Dieburg	Frau Müller	36/251	Tel.: 8291
PSZ-9b	Sozialbetreuung	Frau Loos	54/531	Tel.: 2728
P183-DA-11b	Parkerlaubnis	Herr Scior	34/123	Tel.: 6623
P184DA-2	Brandschutz	Herr Harsch	36/227	Tel.: 6620
P184DA-1	Arbeitsschutz	Herr Anders	36/226	Tel.: 7697
PSZ-4	Sonstige Fragen zu Tarifangelegenheiten	Herr Kottke	54/425	Tel.: 3780

01.05.98

Figure 44 Deutsch Telekom new employee route card

This document gives an idea of the stakeholders involved in the new employee scenario, and it reveals the existence of a process of integration and the vocabulary needed to describe the whole state of affair.

This document is also a good example of a lethal problem in knowledge acquisition: the problem of access to information. Here the natural language used for documents (German) may not be comprehensible to the knowledge engineer. This problem has been raised in several international projects and is time-consuming and money-consuming (train native speakers to analyze it themselves, translate documents,...). Another form of obstacles to information access we encountered was the security restriction on documents. An answer to access problem is to train some end-users to do the analysis them-selves. It can be time-consuming but it is also a good point to ensure the system maintenance at running time.

In order to scale-up the process to a large amount of documents, Natural Language Processing tools can be used to scan corpora (intranet, large sample of documents), as we saw in the first section. A detailed experience was carried out in our team at Renault car constructor [Golebiowska *et al*, 2001].

These tools for text analysis have not been used for O'CoMMA but are extremely helpful since textual documents are the most common type of documents available. However some documents use graphical conventions that are meaningful but not automatically exploitable (e.g. the table format of Figure 44, the graphical layout of the organization chart in Figure 45). For these document, a 'manual' analysis is still necessary whereas for textual documents a semi-automatic analysis can be envisaged.

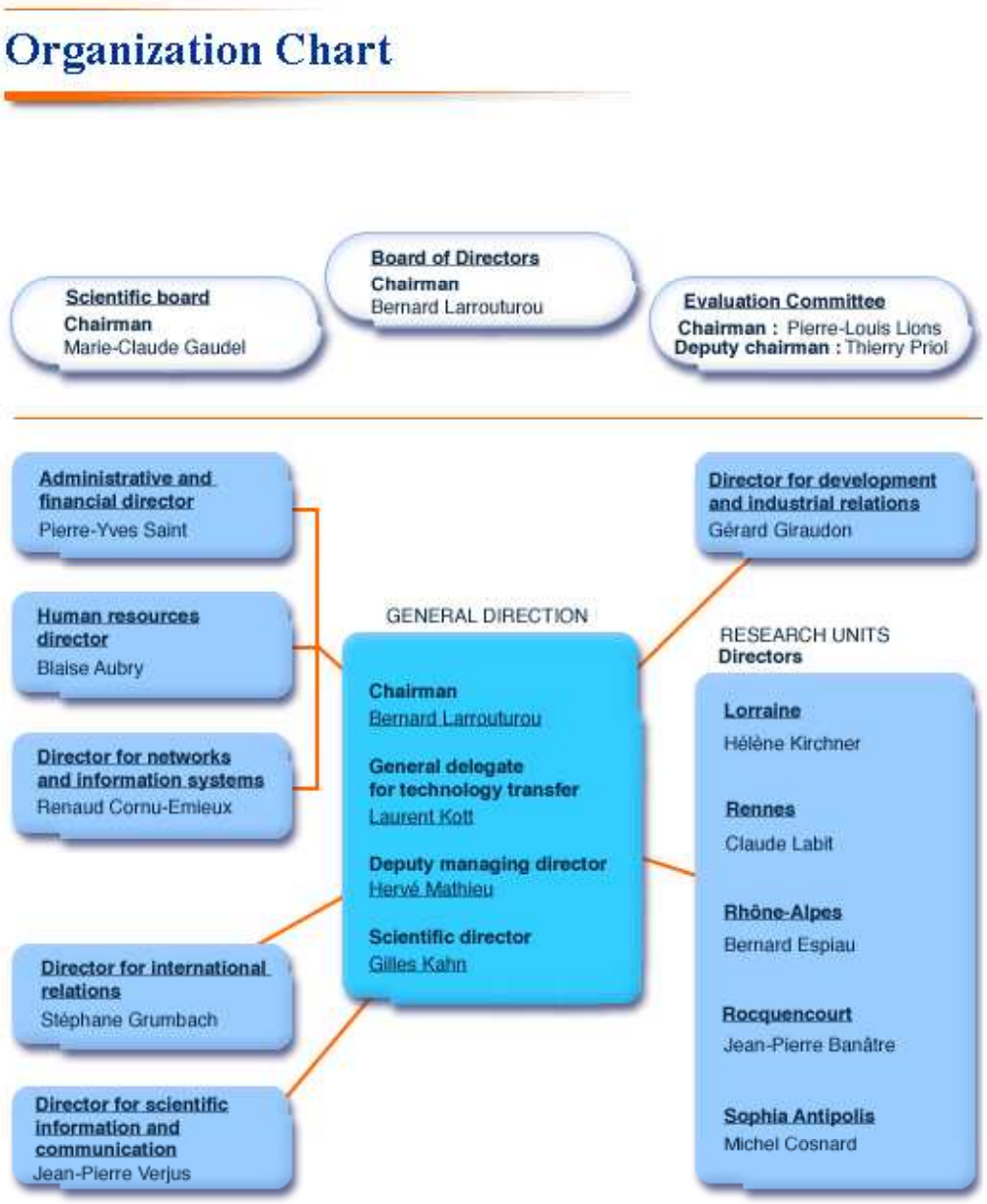


Figure 45 Organization chart of INRIA

5.2.5 Discussion on data collection

For CoMMA we did not use questionnaires so far for data collection, however we envisage to use them during the trial and evaluation to organize the first tests, to structure the use of the first prototypes, and to get feedback from the users.

A recurrent point in the method explained here is the time- and effort- consuming aspects of these methods. Some of them may be partially automated like text-analysis, but most of them are manual. In fact, the key point we are making here is not to extensively use data-collection techniques, but use them in a focused fashion, target subject and objects profiles (eg: for new employee scenario we chose an new assistant thus combining newcomer and document-worker aspects) and above all combine them to cross-check and crossbreed results.

5.3 Reusing ontologies and other sources of expertise

Data collection methods were extremely time-consuming. In order to speed-up the process we decided to also study and *reuse existing ontologies* whenever possible:

- Enterprise Ontology [Uschold *et al.*, 1998]
- TOVE Ontology [TOVE, 2000]
- Upper Cyc® Ontology [Cyc, 2000]
- PME Ontology [Kassel *et al.*, 2000]
- CGKAT & WebKB Ontology [Martin and Eklund, 2000]

The reuse of ontologies is both seductive (it should save time, efforts and would favor standardization) and difficult (commitments and conceptualizations have to be aligned between the reused ontology and the desired ontology). The existing ontologies cited above have not been imported directly or translated automatically. We found that the best way to reuse them was to analyze their informal version as a textual document collected. This was possible only because these ontologies are very well documented. Divergences in the objectives and the contexts of modeling and use between these ontologies and O'CoMMA (cf. the end-users and application scenarios were indeed different) led us to think that no automatic import was possible and that human supervision was compulsory. However natural language processing tools, such as the ones used in the approach proposed by [Aussenac-Gilles *et al.*, 2000], could have helped the analysis. Moreover, translator between formal languages could have eased reuse.

In addition to these contributions we had to consider other informal sources. Some specific sources of expertise helped us structure upper parts of some branches. For instance, we used thoughts from the book "Using Language" from Herbert H. Clark for structuring the document branch on representation systems, providing an expertise on semiotic that was needed and could not be gained through previous data collection techniques (the interviewed stakeholders were not expert in semiotics, and the collected documents did not explicitly contain that information either). Other very specific standards enabled us to save time on enumerating some leaves of the ontology. For instance the MIME standard was an excellent input for electronic format description and the Dublin Core suggested most common global properties of documents.

The systematic use of dictionaries or available lexicons is good practice. In particular, the meta-dictionaries have proved to be extremely useful. They give access to many dictionaries (some of them specialized in specific field e.g. economy, technology...) and therefore they enabled us to compare definitions and identify or build the definition corresponding to the notion we wanted to introduce. We made extensive use of the meta-dictionary [OneLook, 2000] that enabled us to produce the first English expressions of intensions of the O'CoMMA concepts.

Scenarios were used to prune the contributions to the ontology. These scenarios captured the scope needed for the ontology and a shared vision of the stakeholders: thus they helped to decide whether a concept is relevant or not. For instance, in O'CoMMA, we did not reuse the *ownership* relation offered by the Enterprise Ontology since this relation was not useful in our scenarios.

5.4 Terminological stage

The candidate terms denoting concepts that appeared relevant in the application scenarios were candidates for the terminological analysis. Synonymous terms wee selected too, and related terms were considered in a chain reaction. For instance, if we consider the terms *document*, *report*, and *technological trend analysis report* involved in the technology monitoring their candidacies to terminological analysis were linked. The starting point could be the term *document* due to a study of the existing top ontologies, or the term *report*

identified during the interview of the ATOS newcomer or finally the term *technological trend analysis report* encountered when collecting documents for the technology monitoring scenario (e.g.: "technological trend analysis report entitled 'Capitalizing WAP experiences for UMTS transition' "). Candidate terms were organized in a set of informal tables – that form a semi-informal data collection structure. INRIA proposed definitions in natural language for each term. This first terminology was presented to members of the CoMMA consortium and low-level extensions (terms and definitions) were proposed by the industrial partners, for instance:

"**Area Referent:** Observer responsible for an expertise area and who has a group of contributors observers to manage."

It was clearly interesting to have a continuous collaboration between, on the one hand, a knowledge engineer for methodological aspects and bootstrapping of the ontology, and, on the other hand, stakeholders for specific concepts and validation.

The terminological study was at the heart of ontology engineering, it provided the candidate terms for which consensual definitions have to be produced. These definitions expressed the intension of the concepts captured in the ontology. There were three cases:

- One term corresponding to one and only one notion: we labeled the notion with the term.
- Several terms corresponding to one notion: these terms were synonyms, we kept the list of synonyms and chose the most commonly used term to label that notion.
- One term corresponding to several notions: the term was kept, but, noted as ambiguous and several expressions of intensions were defined with non ambiguous labels (e.g. compound terms).

The explicit representation of the two levels (term level and notion level) is a real need. Likewise tools assisting ontologists for the terminological aspects in ontology engineering or tools managing terminology to support users in their interactions with the system are needed.

5.5 Structuring the ontology

The obtained concepts are structured in a taxonomy. The principles behind this structure go back to Aristotle who defined a specie by giving its genus (genos) and its differentia (diaphora): the genus is the kind under which the species, the differentia characterizes the species within that genus. Thus we started regrouping concepts firstly in an intuitive way, then iteratively organizing and reviewing the structure following the extended Aristotelian principles given by Bachimont [2000]. These principles tend to eliminate multiple inheritance which is a problem with the role concepts making an extensive use of this mechanism. One idea would be to introduce multiple view points [Ribière, 1999] and limit the application of these extended principles to a point of view. An approach is proposed in [Kassel *et al.*, 2000] introducing semantic axis as means to group the types of criteria used for the differentia. The extended principles could then be applied to concepts inheriting for the same semantic axis. Likewise, the extensive work of Guarino and Welty [Guarino, 1992; Guarino and Welty, 2000] contributes to clean-up the theoretical foundations of ontology engineering: they provide definitions, theoretical framework and constraints to be satisfied by the taxonomy so that ontologists relying on these definitions can check some validity aspects of their subsumption links. The only problem is that, as far as we know, no tool is available to help an ontologist do that work easily and independently of a formalization language; it is a titanic work to apply this theory to large ontologies. These contributions appeared to be adapted to validation of top ontologies ensuring, by extension, a minimal coherence in the rest of the ontology.

The three common approaches when building an ontology:

- *A Bottom-Up approach*: the ontology is built by determining first the low taxonomic level concepts and by generalizing them. This approach is prone to provide tailored and specific ontologies.
- *A Top-Down approach*: the ontology is built by determining first the top concepts and by specializing them. This approach is prone to the reuse of ontologies.
- *A Middle-Out approach*: core concepts are identified and then generalized and specialized to complete the ontology. This approach is prone to encourage emergence of thematic fields and to enhance modularity.

We first thought that it would be interesting to try a cross approach by merging bottom-up and top-down approaches: it would enable to associate both the benefit of being specific and the ability to reuse other ontologies. After our experience, we are not convinced that there exists a purely top-down, bottom-up or middle-out approach. They seem to be the three complementary perspectives of a complete methodology. It seems to us that the activities of finding structure by specialization from a generic concept, or by

generalization from a specific concept are concurrent processes present at every level of depth in the ontology (bottom, middle or top) and at different detail grains (concepts or groups of concepts). The holistic nature of knowledge seems to lead to the holistic nature of ontologies, and the holistic nature of ontologies leads to the holistic nature of methodologies to build them. For a given case, an approach can mainly rely on one perspective (e.g. some ontologies of chemical substances made extensive use of bottom-up approach), but we would not oppose the different approaches: they rather represent three perspectives combined in ontology engineering. When engineering an ontology, an ontologist should have the tasks defined in these three perspectives on the go at one time.

In our case, some tasks were performed in parallel in the different perspectives, for instance:

- Top-down approach: we studied existing top-ontologies, and upper parts of relevant ontologies to structure our top part and recycle parts of existing taxonomies;
- Middle-out approach: we studied different branches, domains, micro-theories of existing ontologies as well as core subjects identified during data-collection. It helped us understand what were the main areas needed and regroup candidate terms;
- Bottom-up approach: we used reports from scenario analysis and data-collection traces, so as to list scenario specific concepts and then to regroup them by generalization.

The different buds (top concepts, core concepts, specific concepts) opening out in the different perspectives were the origins of partial sub-taxonomies of O'CoMMA. The objective then was to ensure the joint of the different approaches and each time an event occurred in one perspective it triggered checks and tasks in the others e.g. : if you discover in the bottom-up perspective that some specific concepts of a domain are relevant, it is interesting in the top-down perspective to try to find existing top level structure of this domain and in the middle-out perspective to find the central concept of this domain.

5.6 From semi-informal to semi-formal

Starting from the informal terminology we ended-up separating attributes and relations from the concepts we obtained three tables (see Figure 39 - b). These tables evolved from a semi-informal representation (terminological tables of term & notion) towards semi-formal representation (taxonomic links, signatures of relations). Extracts from these tables are given as examples in Figure 46 and Figure 47. They are intermediary and maturing working-documents bridging the gap from data collection to formalization. In the final version there were three tables:

- The table of concepts (see Figure 46) giving: name of potential concepts (Class), the core concept they are close to or the thematic field they belong to (View), their inheritance links (Super Class), synonymous terms identified (Other Terms), a natural language definition of the notion behind the concepts to try to capture their intension (Natural Language Definition), the source in data collection that triggered their addition to the table (Provider).
- The table of binary relations (Figure 47 - top part) giving: name of potential relations (Relation), the concepts they link (Domain and Range), the thematic fields they cross (View), their inheritance links (Super Relation), synonymous terms identified (Other Terms), a natural language definition of the notion behind the relation to try to capture their intension (Natural Language Definition), the source in data collection that triggered their addition to the table (Provider).
- The table of attributes (Figure 47 - bottom part) giving: name of potential attributes (Attribute), the concept they are attached to (Domain), the basic type of the value taken by the attribute (Range Type), the thematic fields they belong to (View), their inheritance links (Super Relation), synonymous terms identified (Other Terms), a natural language definition of the notion behind the attributes to try to capture their intension (Natural Language Definition), the source in data collection that triggered their addition to the table (Provider).

The last column (Provider) introduces the principle of traceability of concepts, relations or attributes and it is interesting for the purpose of abstracting a methodology from the work done in CoMMA, to know what sort of contribution influences a given part of the ontology. It also enables to trace the effectiveness of reuse. When several sources are given, it means that the notion is a compromise between these different sources; it is a first attempt that is of course not sufficient and much more work is needed to capture and make explicit the rationale (this reports is in a way a contribution to that point).

Class	View	Super class	Other Terms	Natural Language Definition	Pr
Thing	Top-Level;	;	;	Whatever exists animate, inanimate or abstraction.	Us
Entity	Top-Level;	Thing;	;	**Thing** which exists apart from other **Things**, having its own independent existence and that can be involved in **Events**.	Us Ph
Event	Top-Level; Event;	Thing;	;	**Thing** taking place, happening, occurring; usually recognized as important, significant or unusual	Us
Gathering	Event;	Event;	;	**Event** corresponding to the social act of a group of **Persons** assembling in one place	Us
Formal Gathering	Event;	Gathering;	;	**Gathering** agreeable to established mode, forms, conventions and requirements, methodical ; well planned and organized, not incidental, sudden or irregular	Us
Meeting	Event;	Formal Gathering	;	**Gathering** formally arranged for a particular purpose, usually in a dedicated room and/or around a table	Us
Person	Top-Level; Person;	Living Entity;	;	**Living Entity** belonging to mankind, an individual human being.	Us
Professional	Organization; Person;	Person;	;	**Person** who does activities that are characteristic of some job/profession/occupation for a livelihood.	Us Cy
Employee	Organization; Person;	Professional;	;	**Professional** who works for an organization in return for financial or other compensation. Disjoint with **Self-employed Professional**.	Us Cy
Organizational Entity	Organization;	Entity;	;	**Entity** recognized by and within the organization	Us EO
Organization Group	Organization;	Organizational Entity;	;	**Organization Entity** composed of other **Organization Entity** working together in a structured way for a shared purpose.	Us To
Organization	Organization;	Organization Group;	;	**Organization Group** including both informal and legally constituted organizations	Us
Organization Part	Organization;	Organization Group;	;	**Organization Group** which is a sub-organization of another **Organization Group**	Us
Group of Individuals	Organization;	Organization Group;	;	**Organization Group** composed of **Organization Individual** only.	
Document	Document;	Entity;	;	**Entity** including anything serving as a representation of thinking	Us
Memo	Document;	Document;	;	**Document** corresponding to a message or other information in writing sent by one person or department to another in the same **Organization**	Us
Newsgroup Message	Document;	Document;	Forum Message;	**Document** corresponding to messages displayed on the Internet and devoted to the discussion of a specified topic	Us

Figure 46 Extracts from original table of concepts

Relation	Domain	Range	View	Super Relation	Other Terms	Natural Language Definition	Sy	Tr	Re	Pr
Relation	Thing	Thing	Top-Level	;	;	Represent a connection between two things				Us
Manage	Organizational Entity;	Organizational Entity;	Organization;	Relation;	;	Relation denoting that an Organizational Entity (Domain) is in charge/control of another Organizational Entity (Range)		Tr		EO
Include	Organizational Group;	Organizational Entity; Person;	Organization;	Relation;	;	Relation denoting that an Organizational Entity (Domain) has as a part another Organizational Entity (Range)		Tr		Us
Employed by	Employee;	Organization;	Organization;	Relation;	;	Relation denoting that an Organization has an Employee working or doing a job for it and pays this Employee for it				Us EO
Has for Activity	Organizational Entity;	Activity Field;	Organization; Activity;	Relation;	;	Relation denoting that an Organizational Entity is working in an Activity Field				Us
Is Interested by	Organizational Entity;	Interest Field;	*;	Relation;	;	Relation denoting that an Organizational Entity is working in an Activity Field				Us

Attribute	Domain	Range Type	View	Super Relation	Other Terms	Natural Language Definition	Pr
Family Name	Person;	literal (string)	Person;	Designation;	Last Name; Surname	The name used to identify the members of a family	Us
Comments	Document;	literal (string)	Document;	;	;	Textual remark or observation about a document	Us
Designation	Thing;	literal (string)	Top-Level;	;	;	Identifying word or words by which a thing is called and classified or distinguished from others	Us
Creation Date	Document;	literal (date & time)	Document;	;	;	Date the document was created	Us
Beginning	Gathering;	literal (date & time)	Event;	;	;	Starting date of an gathering	Us
End	Gathering;	literal (date & time)	Event;	;	;	Ending date of an gathering	Us
Address	Location;	literal (string)	Top-Level;	;	;	Address of a location	Us
Phone Number	Location;	literal (phone)	Top-Level;	;	;	Phone number of a location	Us
Indication	Location;	literal (string)	Top-Level;	;	;	Textual signs/clues pointing to the location ("in the cupboard of the rest room")	Us

Figure 47 Extracts from original tables of relations and attributes

5.7 On a continuum between formal and informal

The informal version of the ontology is not merely an intermediary step that will disappear after formalization, the formal form of an ontology must include the natural language definitions, comments, remarks, that will be used by humans trying to appropriate the ontology. "Ontologies have to be intelligible both to computers and humans" [Mizoguchi and Ikeda, 1997]. This plays an important role in documenting the ontology and therefore in enabling reuse and maintenance of ontologies. The tables previously described evolved from semi-informal to semi-formal until the taxonomic links were sufficiently explicit to be translated in RDFS by scripts (see Figure 39 - c). The ontology content did not change, but its underlying structure evolved from informal tables to formal taxonomic relations usable by software. We call this translation time the formal toppling point: the point at which the ontology toppled over from informal structuring to formal structuring.

Figure 48 shows how RDFS can be used to implement the different levels introduced previously:

- the *terminological level* where collected terms are organized. Relations between the intensional level and the terminological level indicate possible labels for each intension (property `rdfs:label`). An intension with several terms linked to it (e.g. in Figure 48: C_4) is characteristic of the synonymy of these terms. A term with several intensions linked to it (e.g. in Figure 48: T_2) is characteristic of the ambiguity of this term.
- the intensional level where the intensional structure of the ontology is formalized. Relations between the intensional and the extensional level represent the instantiation of a concept. The bundles of relations link an intension to its extension (e.g. in Figure 48: C_8).
- the extensional level where the factual memory is organized (annotations, state of affairs, user profiles). An extension linked to several intensions (e.g. in Figure 48: C_6 and C_7) is characteristic of multi-instantiation.

We kept all the informal views using XSLT style sheets (see Figure 39 - d):

- the initial terminological table representing a sort of lexicon of the memory is recreated at any time by a style sheet (see Figure 49 - h.)
- the tables of concepts and properties we showed previously are recreated by two other style sheets.
- navigation and research between the conceptual and terminological levels is achieved thanks to one style sheet exploiting the label tag of the schema in order to search for concepts or relations linked to a term (Figure 49 a and b)
- a new view as an indented tree of concepts with their attached definition as a popup window following the mouse pointer is constructed by one style sheet (Figure 49 g) but the process is heavy and the use of multiple inheritance makes the tree view to much redundant.
- browsing in the taxonomy of concepts and relations is enabled thanks to two style sheets, as any of the style sheets presented here they can handle different languages for the terminological level thus enabling us to switch for instance from English to French or, as one could imagine, from one jargon to another (Figure 49 c, d and e). The user can also ask for the listing of the extension of a concept or a relation. Note that a sample of this extension can play the role of examples to ease understanding of a notion.
- from a concept one can look for relations having a compatible signature (Figure 49 f).

The taxonomic tree view with its popup window is an interesting improvement. It is a first attempt to investigate how to proactively disambiguate navigation or querying. Before the user clicks on a concept the system displays the natural language definition; this popup window invites the user to check his personal definition upon the definition used by the system and avoid misunderstandings.

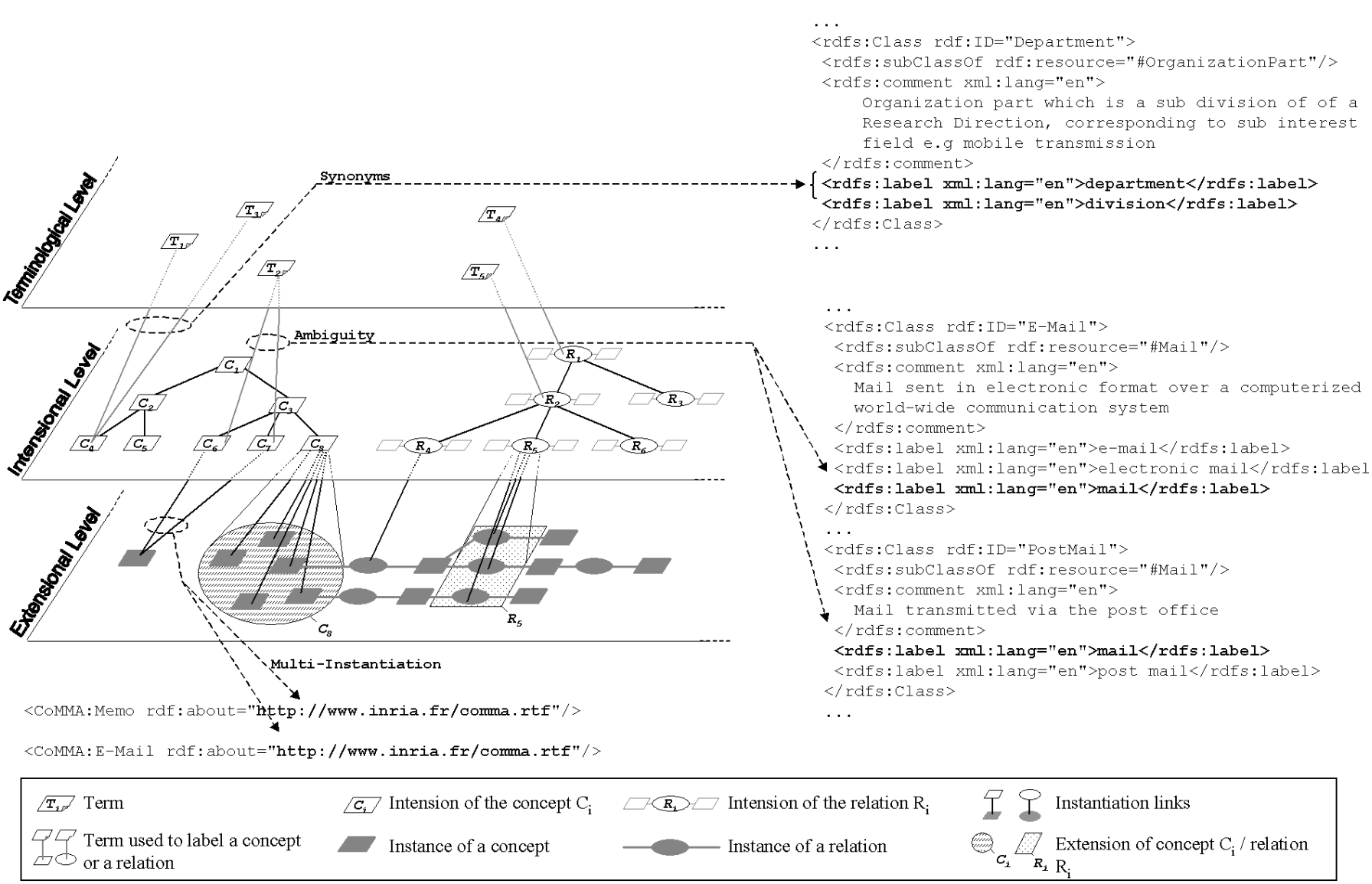
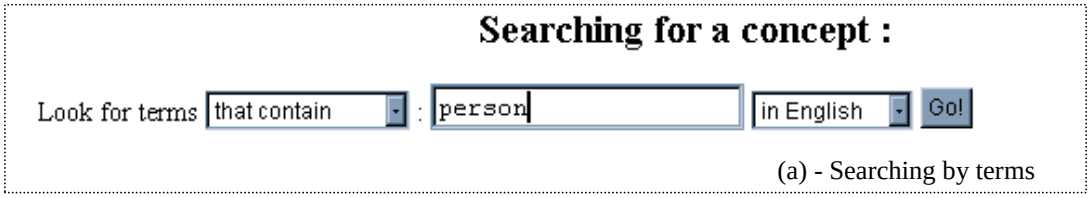
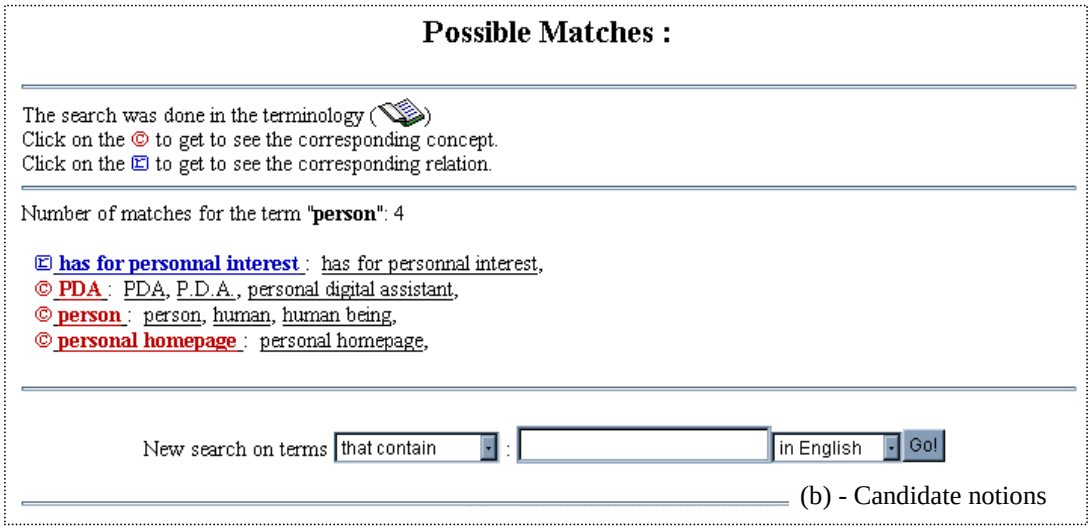


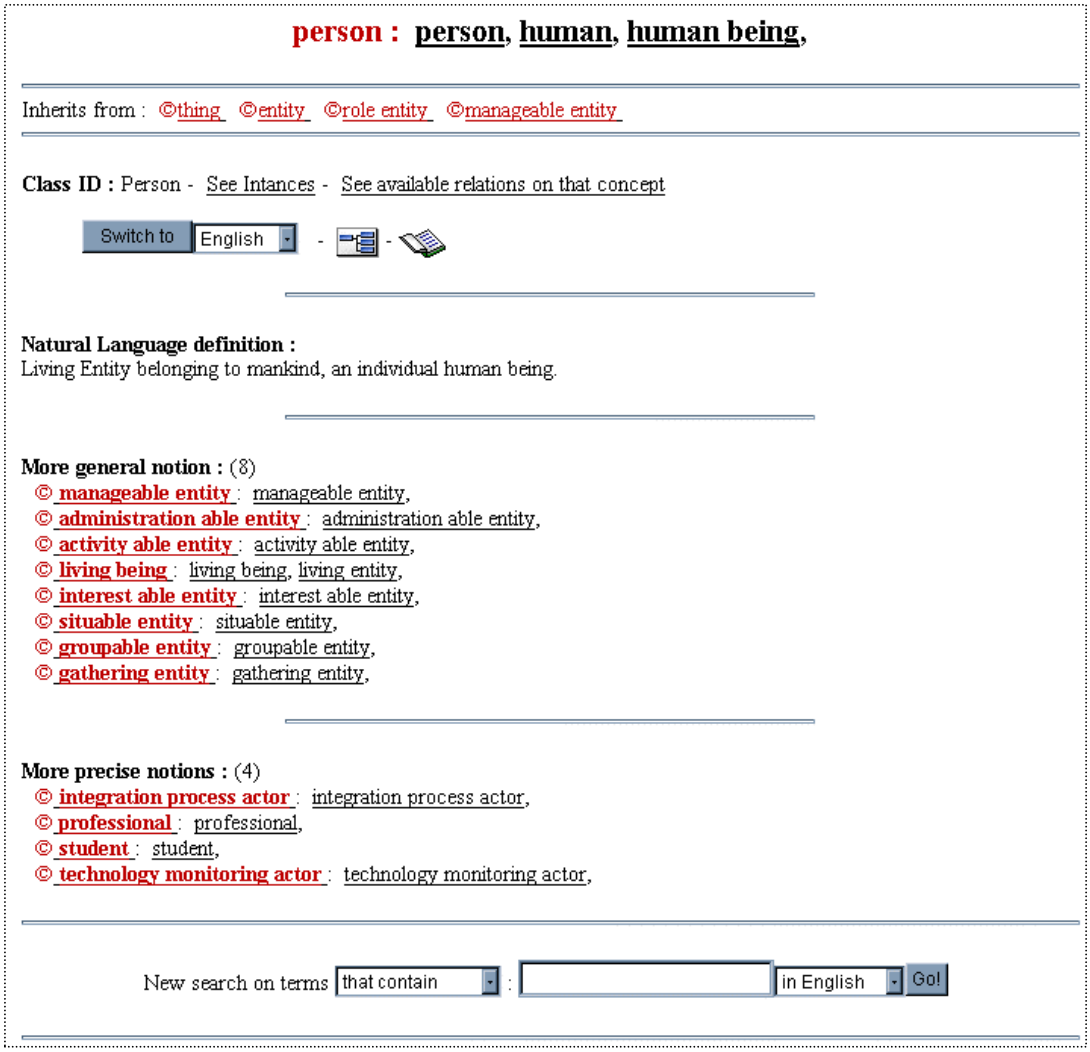
Figure 48 The terminological, intensional and extensional levels



(a) - Searching by terms

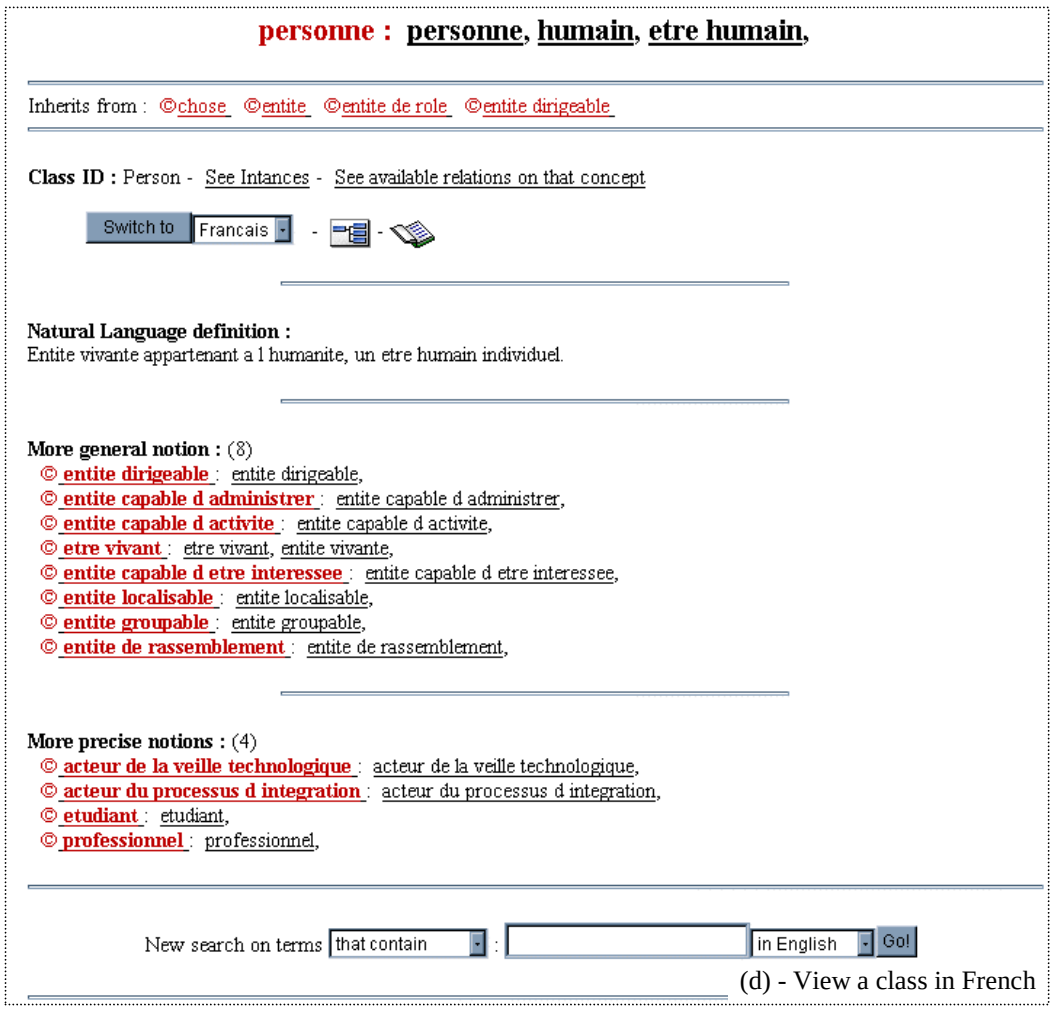


(b) - Candidate notions

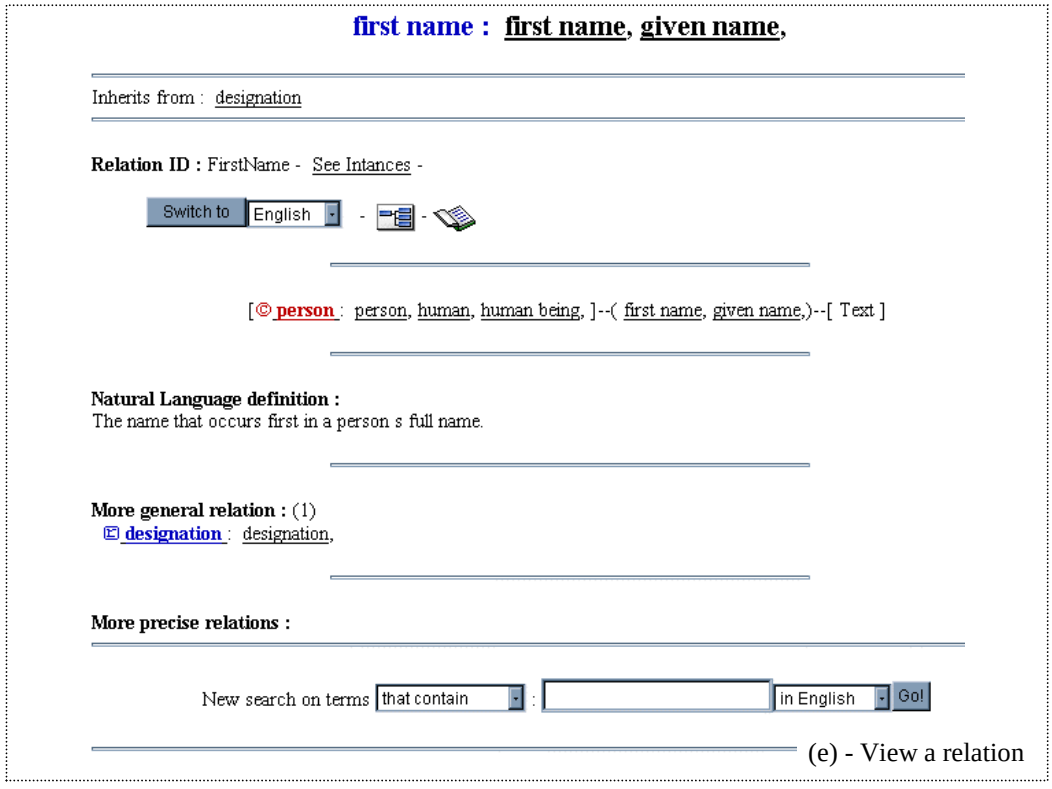


(c) - View a class in English

Figure 49 Browsing the ontology

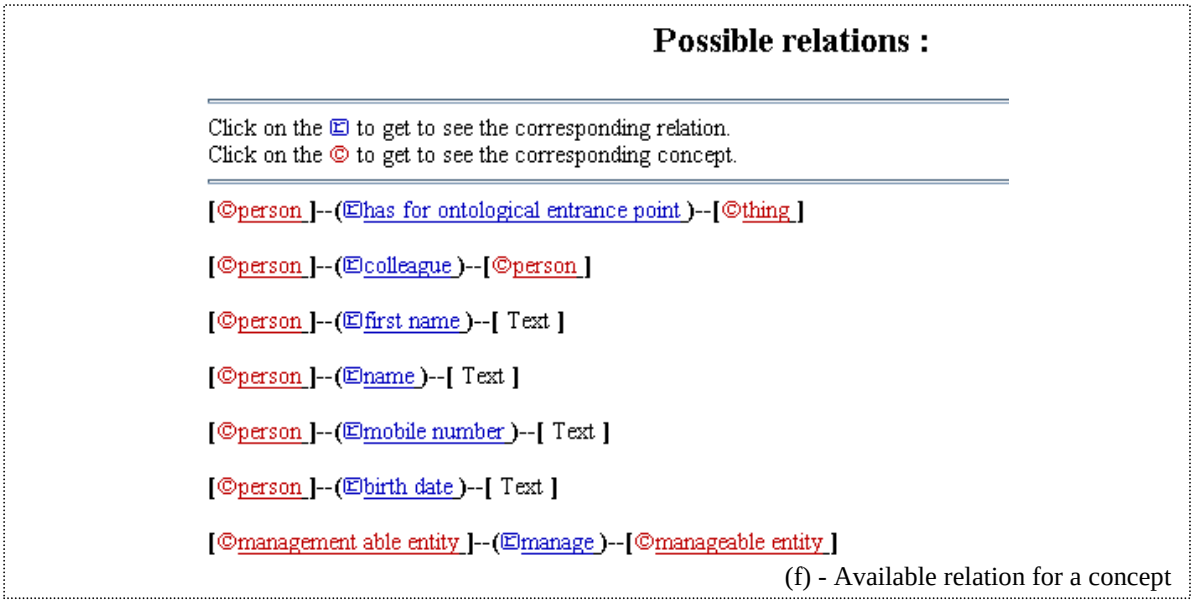


(d) - View a class in French



(e) - View a relation

Figure 49 Browsing the ontology



(f) - Available relation for a concept

(g) - Taxonomy View

Figure 49 Browsing the ontology

M.P.E.G. format	© MPEG	Data File Format of animated images/movie compressed in Moving Picture Experts Group format.
machine language	© machine language	The lowest-level Programming Language that consistw entirely of numbers.
machine learning	© symbolic learning	Domain interested in methods enabling the computers to learn.
magazine	© magazine	Document corresponding to a type of thin book with large pages which contains articles and photographs. It is usually intended to be a weekly or monthly paperback publication.
mail	© mail	Documents sent and delivered through a dedicated conveyance network.
mail	© e-mail	Mail sent in electronic format over a computerized world-wide communication system.
mail	© post mail	Mail transmitted via the post office.
make something	© make something	Activity in which something - tangible - is made from some raw materials.
male	© male	Person who belongs to the sex that cannot give birth.
manage	manage	Relation denoting that an entity is in charge/controls of another entity.
manageable entity	© manageable entity	Entity that can be managed.
management able entity	© management able entity	Entity that can manage another.
manager	© manager	Professional whose primary job is to manage other people, directing their work activity. A Manager tells his or her subordinate workers what to do.
manual	© manual	Reference Document which gives you practical instructions on how to do something or how to use something, such as a machine.
manufacture	© manufacture	Make Something from raw materials or component parts that are combined to produce a product.
map	© map	Document which, properly interpreted, models a region of physical space many times its own size by using

(h) - Terminology View

Figure 49 Browsing the ontology

Chapter 6 : RESULTS AND DISCUSSION

6.1 Introduction

The ontology O'CoMMA is the result produced by the methodology presented in the previous sections. In this part we discuss the characteristics of O'CoMMA and its construction, and we evaluate some aspects of it.

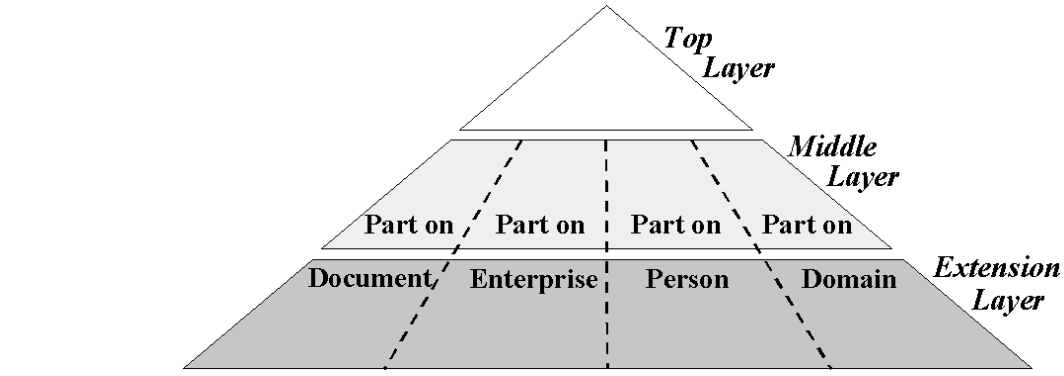
6.2 Guided tour of O'CoMMA

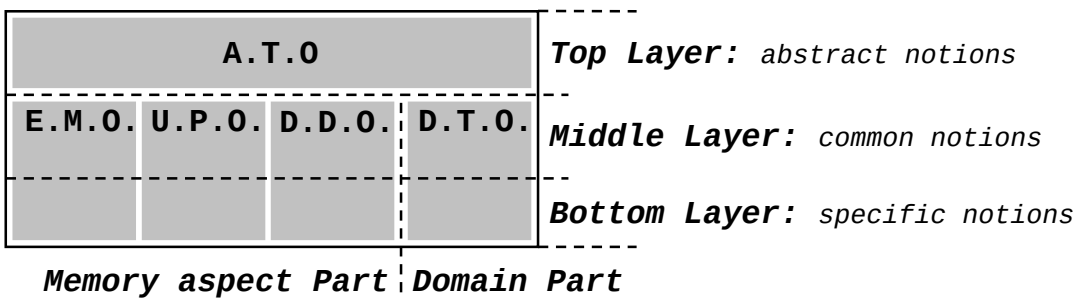
6.2.1 Content and structure

O'CoMMA is divided into three main layers (see Figure 50):

- A very general top that looks like other top-ontologies
- A very large and ever growing middle layer divided in two main branches: (1) one generic to corporate memory domain (documents, organization, people...) and (2) one dedicated to the topics of the application domain (telecom: wireless technologies, network technologies...)
- An extension layer which tends to be scenario-specific and company specific with internal complex concepts (Trend analysis report, Area referent, New Employee Route Card...)

The current ontology contains about 420 concepts organized in a taxonomy with a maximal depth of 12 subsumption hops (using multi-inheritance), about 50 relations and about 630 terms to label these primitives





A.T.O.: Abstract Top Ontology
E.M.O.: Enterprise Modeling Ontology
U.P.O.: User Profile Ontology
D.D.O.: Document Description Ontology
D.T.O.: Domain Topic Ontology

Figure 50 Architecture of O'CoMMA

Concerning equilibrium between usability/reusability of the ontology, the upper part is extremely abstract and the first part of the second layer is describing concepts common to corporate memory (e.g. person, employee, document, report, group, department, ...), therefore they both seem to be reusable in other application scenarios. The second part of the middle-layer deals with the application domain (in our case telecom and building industry). Therefore it would be reusable for scenarios only in the same application domain. The last layer extends the two previous parts with specific concepts that should not be reusable as soon as the organization, the scenario or the application domain change.

6.2.2 Top of O'CoMMA

To unify all the branches of O'CoMMA in a tree, and enable generalization, the top of the ontology defines a set of concepts extended by the other parts.

CONCEPTS	DEFINITION
thing	Whatever exists animate, inanimate or abstraction.
entity	Thing which exists apart from other Things, having its own independent existence and that can be involved in Events.
additional topic	Entity representing subjects that hold attention and possibly something one wants to discover. These topics are additional in the sense that they were not introduced or used anywhere else in the ontology but were identified as relevant for document annotation - domain concepts, general subjects...- (*)
…	
document	Entity including elements serving as a representation of thinking.
…	
non spatial entity	Entity that has no spatial nature and does not pertain to space.
activity, attribute, pattern, consultation trace, push mode trace, **…**	
role entity	Entity that can play a role in a relation.
…	
spatial entity	Entity pertaining to or having the nature of space.
…	
time entity	Entity related to the continuum of experience in which events pass from the future through the present to the past.
…	
event	Thing taking place, happening, occurring and usually recognized as important, significant or unusual.
corporate memory event	Event corresponding to changes in the Corporate Memory (**)
addition	Corporate Memory Event corresponding to content added to the memory.
consultation	Corporate Memory Event corresponding to a user seeking information from the memory
deletion	Corporate Memory Event corresponding to content removed from the memory.
modification	Corporate Memory Event corresponding to content transformed in the memory
update	Modification corresponding to content changed into more recent one.
entertainment event	Event occurring primarily to amuse or entertain Persons.
…	

gathering	Event corresponding to the social act of a group of Persons assembling in one place.
…	

(*) Introduced as the top of the domain branch

(**) Introduced to enable extensions of the agent ACL to describe the system itself

Table 4 Top of O'CoMMA

6.2.3 Ontology parts dedicated to Enterprise Modeling

In both scenarios one of the most relevant aspects of the organizational state of affairs is the company structure. An overview of the main ontology primitives needed for the description at play in our scenarios is presented in Table 5.

CONCEPTS	DEFINITION
organizational entity	Entity recognized by and within the organization.
organization group	Organizational entity which is composed of other Organizational Entity working together in a structured way for a shared purpose.
group of individuals	Organization Group composed of individuals only.
association, club, project, union, unit (*)	
international organization group	Organization Group of international scope, that is, one which has substantial operations, physical facilities, or substantial membership in multiple countries.
local organization group	Organization Group of local scope, that is, members distributed in a local area - a Neighborhood, City, rural region, etc.- or having a local area of activity and concern.
national organization group	Organization Group of nationwide scope, that is distribution throughout some Country of its members and/or activities.
organization	Organization Group including both informal and legally constituted organizations.
consortium, legal corporation, university (*)	
organization part	Organization Group which is a sub-organization of another Organization Group.
cluster, department, division, direction, research direction (*)	
single site organization	Organization Group which has a single location as its physical quarters.
** (see ontology for more details)*	

Table 5 An overview of the concepts used for organizational modeling

This table extracted from O'CoMMA also shows that it may be difficult to respect all theoretical principles. For instance the necessity of having one differentia under a father as advocated by extended Aristotelian principles is not respected here. On the other hand multi-inheritance has been avoided.

To describe and link these concepts some relations are proposed , see for instance Table 6.

RELATION	DEFINITION
administer	Relation denoting that an Entity -Domain- regulates the operations of an Organizational Entity -Range-.
include	Relation denoting that an Organizational Entity has as a part another Organizational Entity.
employed by	Relation denoting that an Organization has an Employee working or doing a job for it and pays this Employee for it.
manage	Relation denoting that an entity is in charge/controls of another entity.
designation	Identifying word(s) by which a thing is called and classified or distinguished from others.
has for activity	Relation denoting that an Entity is carrying out an activity.
is interested in	Relation denoting that an Entity is interested in a topic.
situated	Relation denoting that an Entity is located in a Location.
see ontology for more details (signature, inheritance,...)	

Table 6 An overview of the relations used for organizational modeling

The relations are not structured enough, in particular their taxonomy is too flat. That is why we started to divide for instance 'is interested in' into 'has for professional interest' and 'has for personal interest'. This work should be pursued since taxonomy of relations can turn to be as important as the one of concepts for our scenarios.

These concepts and relations can then be used to describe the enterprise model and capture some relevant aspects such as the departments, their employees and their interest... Figure 51 shows an example of what has been modeled at Deutsch Telekom by an end-user for a trial in CoMMA.

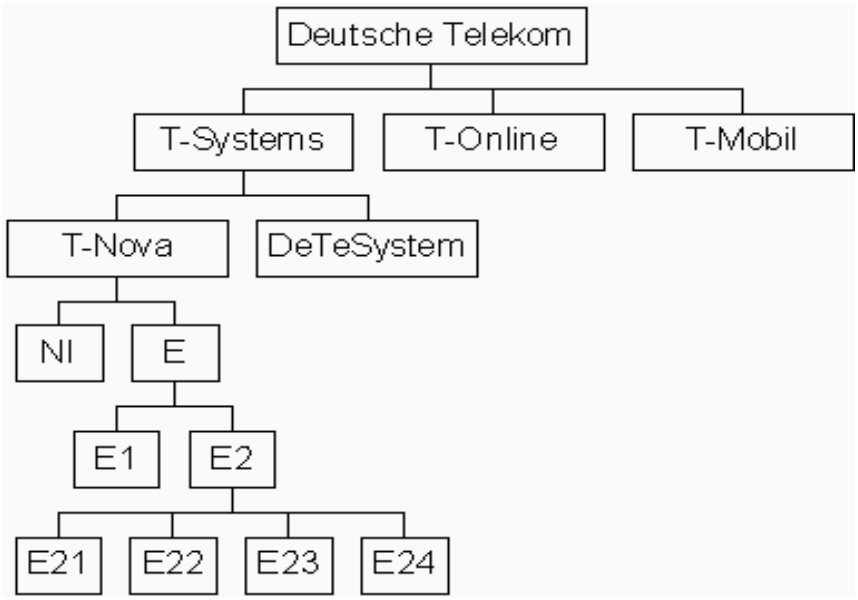


Figure 51 Example of T-Nova organization

Two other organizational aspects are described likewise: employees (technician, student, researcher...) and domain topics (building materials, telecom). For the sake of presentation we will not detail the entire ontology here and we invite the reader to consult the appendix () for more details.

6.2.4 Ontology parts dedicated to User profiles

Profiles are a special type of document, describing some aspects of individual users or groups of users that have been judged relevant for the system inferences.

CONCEPTS	DEFINITION
Profile	Document containing a biographical sketch.
Individual Profile	Profile concerning one individual.
Group Profile	Profile concerning a group of people.
* (see ontology for more details)	

Table 7 Types of profiles

A profile content is also an annotation that can use a number of ontological primitives to describe the user or the group. Here is an example of some information that can be given about a user:

```
<CoMMA:Engineer rdf:about="http://www-sop.inria.fr/acacia/personnel/Fabien.Gandon/">
       <CoMMA:FamilyName>GANDON</CoMMA:FamilyName>
 <CoMMA:FirstName>Fabien</CoMMA:FirstName>
 <CoMMA:BirthDate>31-07-1975</CoMMA:BirthDate>
 <CoMMA:HasForActivity><CoMMA:Research/></CoMMA:HasForActivity>
 <CoMMA:HasForActivity><CoMMA:Development/></CoMMA:HasForActivity>
 <CoMMA:HasForActivity><CoMMA:Education/></CoMMA:HasForActivity>
 <CoMMA:IsInterestedBy><CoMMA:MultiAgentSystemTopic/></CoMMA:IsInterestedBy>
 <CoMMA:IsInterestedBy><CoMMA:KnowledgeEngineeringTopic/></CoMMA:IsInterestedBy>
 <CoMMA:IsInterestedBy><CoMMA:JavaProgrammingTopic/></CoMMA:IsInterestedBy>
 <CoMMA:IsInterestedBy><CoMMA:XMLTopic/></CoMMA:IsInterestedBy>
</CoMMA:Engineer>

<CoMMA:Employee rdf:about="http://www-sop.inria.fr/acacia/personnel/Fabien.Gandon/">
 <CoMMA:EmployedBy>
        <CoMMA:LocalOrganizationGroup rdf:about="http://www.ac-nice.fr/" />
 </CoMMA:EmployedBy>
 <CoMMA:EmploymentContract><CoMMA:Temporary/></CoMMA:EmploymentContract>
</CoMMA:Employee>
```

Figure 52 Example of User description

This profiles says that ...

The profile then uses other primitives to describe the history of use. An important concept here is the consultation trace. An example of such a trace is given here:

```
<CoMMA:ConsultationTrace>
  <CoMMA:Visitor>
    <CoMMA:Employee rdf:about=
        "#http://www-sop.inria.fr/acacia/personnel/Fabien.Gandon/"/>
  </CoMMA:Visitor>
  <CoMMA:VisitedDocument>
    <CoMMA:Memo rdf:about=
        "http://www.myintranet.com/Ada.Lovelace/projects/TIGRA/note28-10.doc"/>
  </CoMMA:VisitedDocument>
  <CoMMA:FirstVisit>2000-11-21</CoMMA:FirstVisit>
  <CoMMA:LastVisit>2000-12-07</CoMMA:LastVisit>
  <CoMMA:VisitCount>17</CoMMA:VisitCount>
  <CoMMA:RatingGiven><CoMMA:GoodRating/></CoMMA:RatingGiven>
</CoMMA:ConsultationTrace>
```

Figure 53 Example of Consultation Trace

This consultation trace says that ...

Here again, we invite the reader to consult the appendix for more details. Relations such as 'is interested by' are exploited for pushing documents. Other primitives are used for system internal needs, and the introduction of ontological preferred entrance points for ontology browsing will be discussed later.

6.2.5 Ontology parts dedicated to Documents

The memory of CoMMA is a documentary one. Therefor O'CoMMA includes a branch on Documents. We only give the top here, but it is deeper and also extended by users to include company specific documents.

document
abstract,
advertisement, publicity, promotion,
article,
book,
chart,
course, training document,
documentary file,
extracted document,
form,
illustration,
index,
index card,
ISSN holder document,
logo,
mail,
map,
memo,
minutes,
narration, story, account,
news,
newsgroup message, forum message,
official document,
presentation,
proceedings,
profile,
reference document,
report,
scenario analysis,
speech,
spreadsheet, spread sheet,
thesis,
transparency, slide,
transparency show,
trend analysis,
web page, web site,
web site,
see ontology for more details (definitions, sub concepts...)

Table 8 Extract from the documents branch

6.2.6 Ontology parts dedicated to the Domain

There are several domains in O'CoMMA. We only presents the top of this branch that is extensively completed by end-users:

additional topic
agriculture,
aquaculture,
biology,
building,
cognitive sciences,
computer science,
earth observation,
economic science,
human science,
mathematics,
music,
physics,
social science,
telecommunications,
see ontology for more details (definitions, sub concepts...)

Table 9 Extract from the topic branch

6.2.7 The hierarchy of properties

The current hierarchy of properties (there are 79) is given in Figure 54.

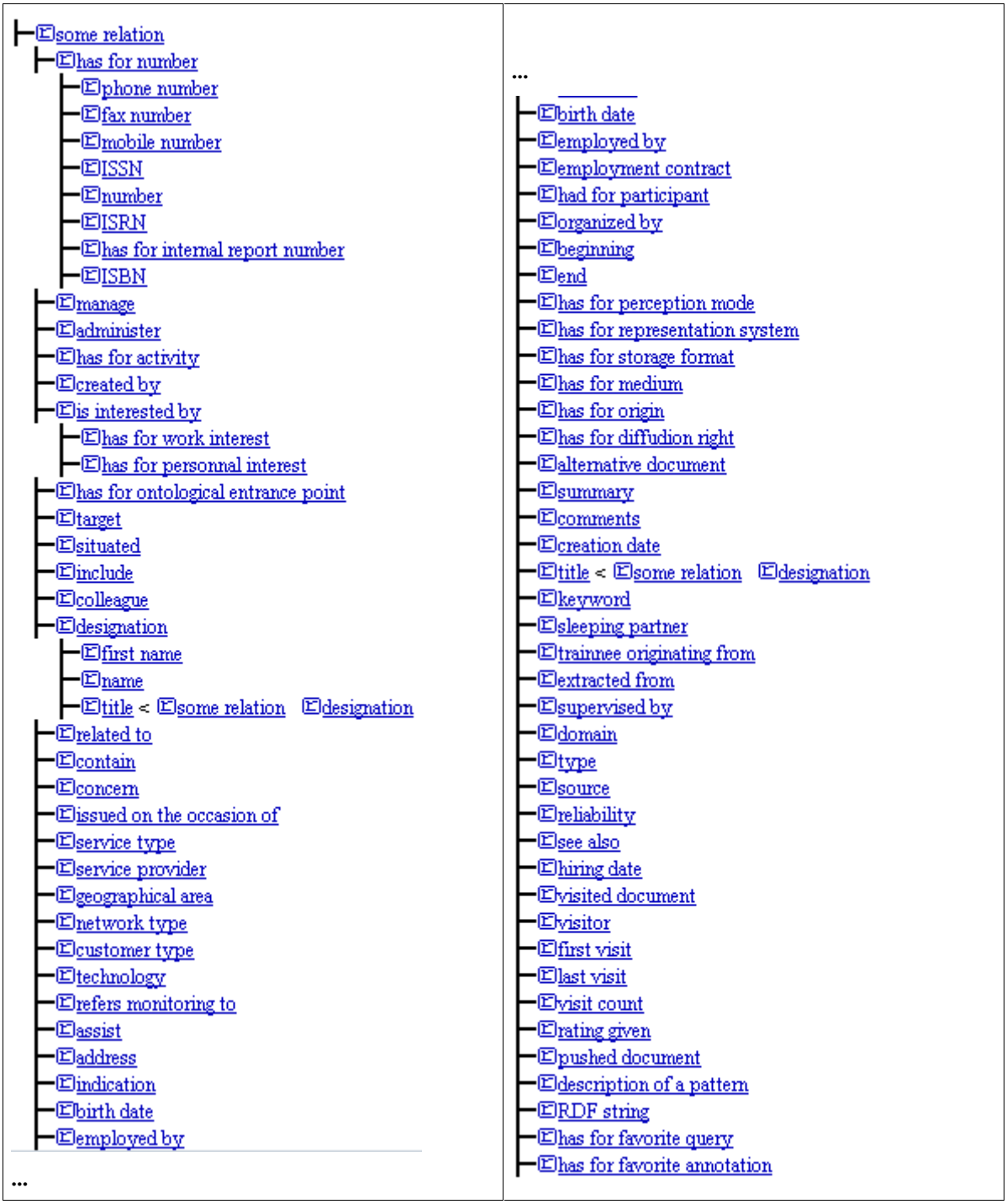


Figure 54 Hierarchy of properties

The deepness of this hierarchy is 2 which is very low.

6.3 End-Users' extensions

At the end of the first year of the CoMMA project, one of our partners, Telecom Italia, had to leave the project and to be replaced by a new partner, CSTB (French building research center). Although it was unfortunate for us to lose our Italian partner, this event enabled us to witness the appropriation of the ontology and its extension by the new partner. We reproduce here some of the tables created by CSTB to require new extensions and we discuss these extensions in comparison with the ontology structure depicted at the beginning of this chapter in Figure 50.

6.3.1 Thematic overview of extensions:

6.3.1.1 Organizational entities

Notion	**Definition**
Partner	Any organization with which the CSTB is associated and collaborates. The co-operation can be limited (e.g. for the realization of a contract for a customer) or durable (mutual recognition of the evaluation procedures and test results, institutional partnership).
Competitor	*(No consensual definition given)*
Supervision authorities	CSTB is a public and commercial organization under the supervision of the Housing Ministry.
Customer	Manufacturers, building contractor, engineering firms, architects and contracting authorities which form CSTB's customers.
Subsidiary company	*(No consensual definition given)*

Table 10 Organizational entities extensions

These extensions are mainly situated under the 'organization' concept. Depending on the context, the same organization can adopt those different status therefore multi-instantiation will be used.

6.3.1.2 Organizational parts

Notion	**Definition**
Management committee	Formed by the President, the Director, the Director of Research and Development Managing Board and the Technical Director.
Management board	Formed by all heads of services.
Department*	Thematic grouping of services (for example, the Security Department counts 2 services: "Structures" and "Fire").
Service*	Basic functional unit of CSTB. A service is part of a department and is composed by several divisions or poles.
Division*	Functional subdivision of a service. It counts generally 10 to 25 people.
Pole*	Functional subdivision of a service. It counts generally 2/3 to 7/8 people
Test Laboratory	It is attached to a service or a division.
** The definitions of these concepts are currently being discussed within CSTB. We will be able to give more precision later.*	

Table 11 Organizational parts extensions

These extensions are mainly situated under the 'organization part' concept. An interesting problem shown here is that CSTB seems to have a problem to reach a consensual definition within its organization.

6.3.1.3 CSTB's expertise areas

These areas are described in the domain part of O'CoMMA. What is interesting here is that this domain ontology was provided by librarians of CSTB in the form of a nomenclature used for indexing documents in their library. An extract from this nomenclature in shown in Figure 55.

liste thématique de présentation des documents reçus à la documentation paris-champs

10 - sciences appliquées au bâtiment
- **11 essais - mesures - métrologie**
- **12 acoustique**
- **13 aérodynamique**
- **14 résistance mécanique et stabilité**
- **15 thermique, hygrothermique et éclairage**
- **16 analyse et traitement de l'eau**
- **17 mécanique des sols - génie civil**
- **18 climatologie**
- **19 énergie**

20 - technique et technologie des ouvrages et matériaux
- **21 aménagements extérieurs - voirie, assainissement**
- **22 gros œuvre**
  - **221 structure**
  - **222 enveloppe**
  - **223 toiture**
  - **224 façade**
  - **225 fondations**
- **23 second œuvre**
  - **231 menuiserie (porte, fenêtre, volet)**
  - **232 isolation acoustique et thermique**
  - **233 revêtements sols et murs**
  - **234 cloisons**
  - **235 conduits et gaines**
- **24 équipements**
  - **241 génie énergétique**
  - **242 équipements sanitaires**
  - **243 éclairage**
  - **244 Dominique - automatisme**
- **25 matériaux de construction - produits de construction**
- **26 pathologie - corrosion**
- **27 chantier**

30 - sciences économiques sociales et humaines
- **3100 prospective - recherche - innovation**
- **3200 secteur du bâtiment**
  - **3210 urbanisme**
  - **3220 politique de la ville**
  - **3230 habitat**
  - **3240 politique et financement du logement**
- **3300 sciences humaines**
- **3400 économie**
  - **3410 économie de la construction**
  - **3420 économie de l'énergie**
  - **3430 données statistiques**
  - **3440 management**
- **3500 acteurs de la construction**
  - **3510 métiers du bâtiment**
  - **3520 formation professionnelle**

(...)

Figure 55 Extract from librarian nomenclature.

The librarian nomenclature is an extremely interesting document for the domain part ontology. It enabled to generate a first taxonomy very quickly. The only thing missing are the definitions attached to the themes and work on making explicit the notions is still undergoing.

6.3.1.4 Persons

This part is about the extension on persons and their characteristics (profession, activity, etc.) .

Notion	Definition
Profession	There are 4 fields (defined in a 1954 decree), called “professions”, structuring CSTB’s activities: research, technical consulting, quality assessment and dissemination of knowledge. Those professions apply to each expertise areas (climatology, thermology….).
Research*	Work on innovative technologies and solutions to future needs and requirement of builders, manufacturers and end-users.
Consulting*	Scientific and technical consulting aims to find innovative solutions to the complex engineering problems that conventional methods are unable to solve.
Quality assessment	Evaluation, assessment and certification of building products and process.
Dissemination of knowledge	CSTB produces and disseminates information through various products and supports (internet, publications, training sessions…).
** These concepts are already included in the ontology but, in CSTB scenario they have a specific meaning.*	

Table 12 Profession extensions

Notion	Definition
External people	People from another company working for a limited period of time at CSTB.
Auditor-Inspector	To add to employee status.
Head of division	*(No consensual definition given)*
Head of pole	*(No consensual definition given)*
Laboratory manager	*(No consensual definition given)*
Post-doctorant	*(No consensual definition given)*
Archivists	To add in "Technical Monitoring Actor"

Table 13 Roles extensions

These extensions are mainly situated under the 'professional' and 'person' concepts. An interesting problem shown here is that some border notions of the ontology bottom and middle layers are judged incompatible with the home definitions of CSTB. This means adjustments have to be done and these concepts have to be customized. Some of these extensions concern activities and therefore will go into the domain part of the ontology, most of the others will go into the person branch of the ontology.

6.3.1.5 Documents

Notion	Definition
Final Report	Concludes and synthesizes the results of a research action or a consultancy contract.
Intermediate report	Punctual report produced at the end of each step of a research action or a consulting contract (state of the art, experiment…).
Activity report	Annual report written by each service in order to present its activities. It contains a list of the service’s non confidential publications.
Research report	Report on a study founded by public authorities
Consulting report	Report on studies performed for clients. Most of them are confidential.
Training period report	Report written by a student at the end of its training period. Rarely confidential, these reports deal with very restricted area.
Standards	*(No consensual definition given)*
Patent	*(No consensual definition given)*
File	Thematic file, regularly updated and made with heterogeneous material (articles, references, synthesis…).
Training course book	Created by the « training » team of CSTB with the collaboration of other departments. These documents are distributed to participants of conferences, seminars, training session ... organized by CSTB.
Information forms	Written by the engineers and researchers to share their (informal) information.
Trends synthesis	Synthesis written by an expert on the trends of a technological area.

Confidential Document	The diffusion is restricted to a defined community. There are different levels of confidentiality for internal or external diffusion. A document can be composed of confidential parts or not confidential parts (for example: the reference and the abstract can be freely diffused but not the integral text).
Public document	The diffusion is not subjected to any restriction.
Internal Document	Internal production (Information letter, Training course book, Reports, Intranet page …)
External Document	Books, articles…. acquired from an external source and written without the participation of any people from CSTB.
Paper Document	Paper support
Electronic Document	Electronic support
Extract	Document extracted from an other (ex.: communication of congress, article of journal…).

Table 14 Document extension

These extensions are purely extensions of the documentary part of the ontology. It shows a perfect case of reuse and extension of the ontology by the end-user. A whole new part would have to be modeled however if CSTB wants information flows to be captured and precisely identify which documents are preferentially manipulated by which actors.

6.3.2 Discussion on extensions

The previous extension tables show a case where an end-user who did not participate to the original construction of O'CoMMA, can appropriate itself the ontology and customize it mainly by extension and revision of the middle layer. The use of the librarian nomenclature for domain extension proved an excellent move and the involvement of librarians in the ontology design process is a priceless asset. Librarians are aware of all the problems of thematic indexing of document. They have tools and models ready to be used and reused for ontology engineering. Together with technology monitoring people, they are examples of existing profiles in the organization roles that are ready to participate and enable the ontology and memory creation and maintenance with a moderate overcost (since the roles and infrastructures already exist). In an other project with CSTB (APROBATIOM), natural language processing tools have been coupled together with classical data collection techniques and feedback from the tools was not only interesting for us to collect candidate terms but also for end-users who saw the emergence of thematic axis they had not detected and explicitly used for indexing yet.

However here not all the extensions suggested by CSTB will be accepted. For instance, extensions for security management on documents could be accepted but even if the conceptual vocabulary was made available it would mean a tremendous software additional development to get the system to exploit these aspects. These computational extensions are feasible but they were not part of the original scenarios and therefore were completely ignored until now.

As you probably noticed, the quality of definitions is extremely heterogeneous. Sometimes only terms were proposed by end-users. These propositions are either refused until the end-user proposes an associated definition, or they are returned with a proposed definition that has to be accepted. Concepts that are not used in the scenarios are refused. Definitions are discussed and revised with users to eliminate, incoherence, circular definitions, fuzziness (i.e. the context of the ontology does not enable us to ensure that the interpretation of the definition will be unique). Examples of discussions are:

- "Auditor - Inspector" : the question raised was that having a closer look at the definition proposed it did not imply that the auditor be an employee, however the super class advocated by end-users was employee ; this had to be discuss to remove the incoherence.
- "management comity" : the concept was placed under groups but the definition stated that it was a group of individuals. Since the concept " a group of individuals" exists in the ontology, "management comity" was moved below.
- "division" and "department" were both label of one concept ; users expressed their will to separate them and new concepts were created.
- a list of "head of ..." was given by the users describing the different types of chefs. They were restructured under an new concept "head / chef" created to represent what they have in common
- an "Pole contains 2 to 8 persons" and "a division 10 to 25" ... the question raised was what is a group of 9 persons ?
- finally one of the end-users says "an index card is a news" and the other says "an index card is a report" this means the ontology of each end-user are not compatible on that point: two ontologies / two views are needed for that part

6.4 Querying and annotating through ontologies: from conceptual concerns to users' concerns

In order to illustrate what an annotation looks like when expressed in RDF, we give in Figure 56 an example of annotation about a short movie presenting "Mediation" a project of unified interface access to heterogeneous catalogs.

```
<rdf:RDF
 xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
 xmlns:rdfs="http://www.w3.org/TR/1999/PR-rdf-schema-19990303#"
 xmlns:CoMMA="http://www.inria.fr/acacia/comma#">

 <CoMMA:Presentation rdf:about="http://fapollo:8080/comma/doc/mediation.mov">
  <CoMMA:Title>Presentation of the purposes of Mediation</CoMMA:Title>
  <CoMMA:HasForPerceptionMode><CoMMA:VisualPerceptionMode/></CoMMA:HasForPerceptionMode>
  <CoMMA:HasForPerceptionMode><CoMMA:AudioPerceptionMode/></CoMMA:HasForPerceptionMode>
  <CoMMA:HasForRepresentationSystem><CoMMA:French/></CoMMA:HasForRepresentationSystem>
  <CoMMA:HasForRepresentationSystem>
     <CoMMA:TalkingMovieRepresentation/>
  </CoMMA:HasForRepresentationSystem>
  <CoMMA:Target>
   <CoMMA:OrganizationalEntity>
    <CoMMA:IsInterestedBy><CoMMA:KnowledgeManagementTopic/></CoMMA:IsInterestedBy>
   </CoMMA:OrganizationalEntity>
  </CoMMA:Target>
 </CoMMA:Presentation>
</rdf:RDF>
```

Figure 56 Example of annotation based on O'CoMMA

This annotations says that the resource `http://fapollo:8080/comma/doc/mediation.mov` is a presentation with the title "`Presentation of the purposes of Mediation`" it uses visual and audio perception. It is a talking movie in French and is especially targeted to organizational entities (persons or groups) interested in knowledge management.

Then Figure 57 shows a query pattern that could match such an annotation because it is looking for titles of documents targeted to entities interested in the 'Knowledge Engineering Topic'.

```
<CoMMA:Document CoMMA:Designation='?'>
 <CoMMA:Title>?</CoMMA:Title>
 <CoMMA:Target>
  <CoMMA:InterestAbleEntity>
   <CoMMA:IsInterestedBy><CoMMA:KnowledgeEngineeringTopic/></CoMMA:IsInterestedBy>
  </CoMMA:InterestAbleEntity>
 </CoMMA:Target>
</CoMMA:Document>
```

Figure 57 Example of query based on O'CoMMA

From the above examples, it should be clear that there is a vital need for interfaces offering ergonomic views to bridge the gap between the users' concerns level and conceptual structures level. Interfaces such as the one currently used for development purposes (see Figure 58) can not be handled as they are to end users.

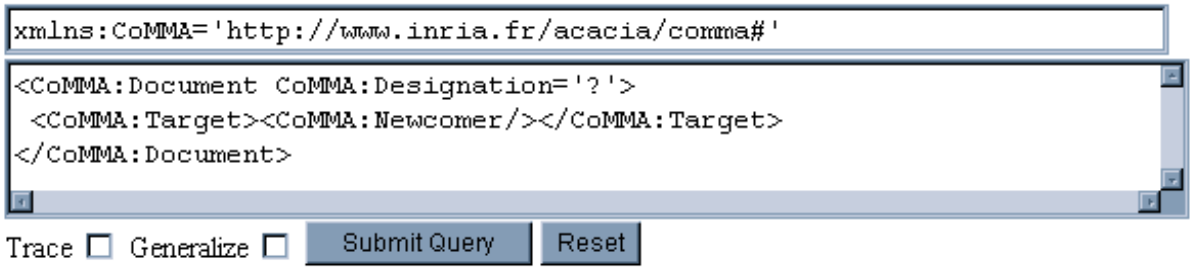


Figure 58 Tester query interface

Industrial partners confronted to the current ontology explained that it is too much complex hence abstruse to people. Especially the upper part of the ontology introduces philosophical distinctions extremely interesting from a modeling point of view (the top of the ontology provides sound building blocks to start modeling and ensure coherence in the rest of the ontology) but extremely abstruse and usually useless for typical users of the system. Moreover the higher you are in the taxonomy the more difficult the agreement is. Two colleagues will more easily agree on the modeling of concepts they manipulate and exchange in their daily work (e.g. a news is a type of document presenting new information) than on the top of the ontology that requires a higher level of abstraction and deals with concepts that we are not used to discuss every day (e.g. things are divided between entities and situations, entities being things capable of playing a role in a situation). The top-level deals with cultural and even personal beliefs. Its concepts are useful for system internal manipulations (e.g. generalization of queries, structuring of higher layers) but not for the direct interaction with users. An ergonomic and pedagogical representation interface is a critical factor for the adoption of the ontology by the users; if the user is overloaded with details or lost in the meandering of the taxonomy, s/he will never use the system and the life-cycle of the ontology will never complete a loop.

In ACACIA we are currently studying different types of interfaces to annotate and query. And we must admit that results from the first prototypes show that the ergonomics issues are far from being solved.

The first example given below shows the interface developed in APROBATIOM where we are interested in assisting stakeholders of a project in the domain of construction. As shown in Figure 59, the interface is purely in HTML. The left part enables us to navigate in the ontology to pick concepts or relations and the right part enables us to build the query.

Figure 59 Query interface in APROBATIOM

We introduced a terminological level in O'CoMMA in order to explicitly capture and manage the relations between notions and terms that may be used to refer to them. It is an asset that should be thoroughly exploited when interfacing the user with the system. The first thing one can do is to offer a keyword-fashion interface where the user enters terms that are translated into a list of concepts (if a correspondence can be found) used for querying. This is the first mode of the terminological interface shown in Figure 60.

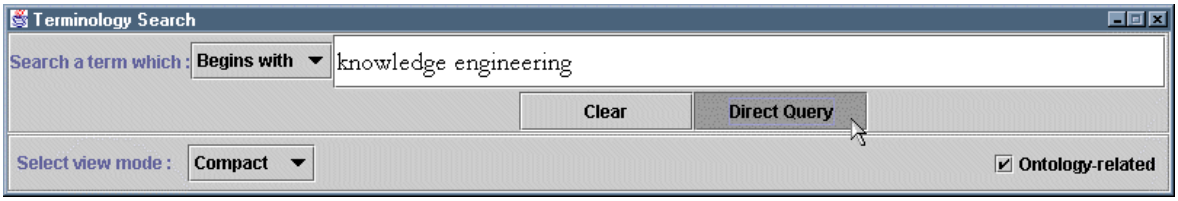


Figure 60 Simple mode of terminological interface

While the previous interface is simple, it does not really exploit term-notion links to disambiguate the dialog between the user and the system. Therefore in a more complex mode the interface proposes the user to make shopping in the notions available to him in the ontology; the list of notions being derived from the terms or just the first characters the user typed. Figure 61 shows this interface using the now natural Web metaphor of the trolley / shopping cart. The user virtually drags and drops the notions relevant to the document s/he is looking for into the shopping basket and submits it when all the notions s/he is looking for are inside.

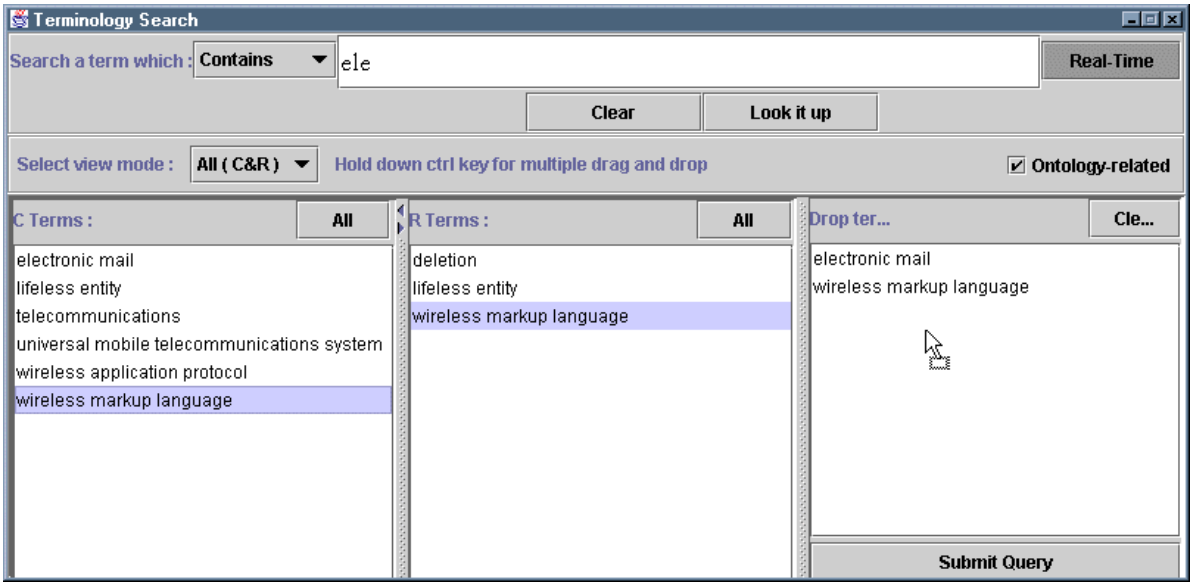


Figure 61 Extended mode of terminological interface

Some of the notions are natural concepts, others are relations. In the previous interface they are treated alike. This interface does not allow the user to structure the query or constrain some fields. This is the purpose of the expert interface shown in Figure 62.

In Figure 62 the user is building a query asking for annotation talking about sports event in "Le Man" and Renaud Cars with an engine dated 1995.

This last interface is extremely powerful but as a drawback, it is much more complex to use. We are currently trying to merge the terminological interface with this one to use the notions in the cart as ontological tree entrance point for query elicitation in the expert interface thus saving the user from browsing the ontology.

To these interfaces we must add the ones developed to browse and query the ontology itself. Ontologist are a special type of users that requires a special type of interface. Moreover the ontology and its terminology can also be used to present and document the results from a query. Starting back from the query of Figure 58 asking for documents targeted at newcomers the results given by the systems could be:

- presented in English by extracting terms from the ontology as shown in Figure 63.
- presented in French (Figure 64) with the same ontology but a different terminological level. It could also be used to adapt to the user's jargon.
- documented, for instance Figure 65 shows the use of natural language definitions in the ontology to disambiguate the term organization chart.

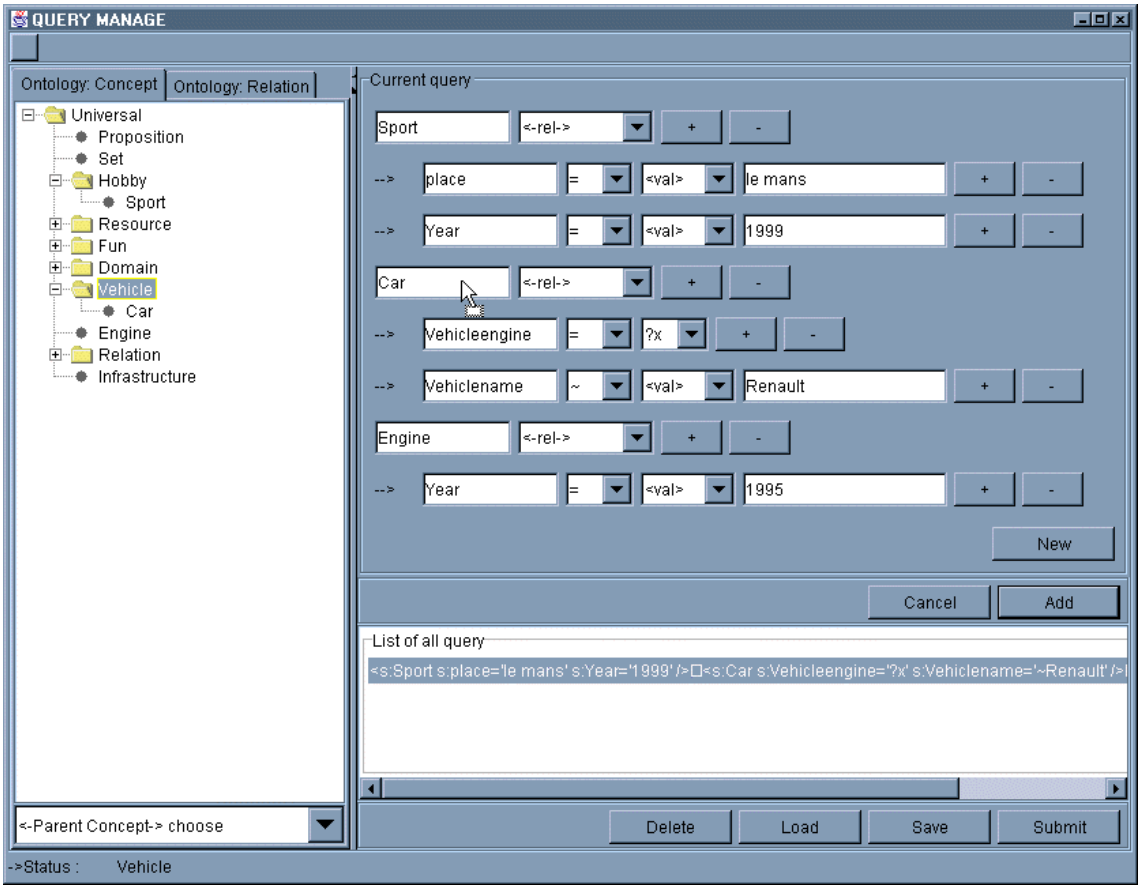


Figure 62 Expert query interface

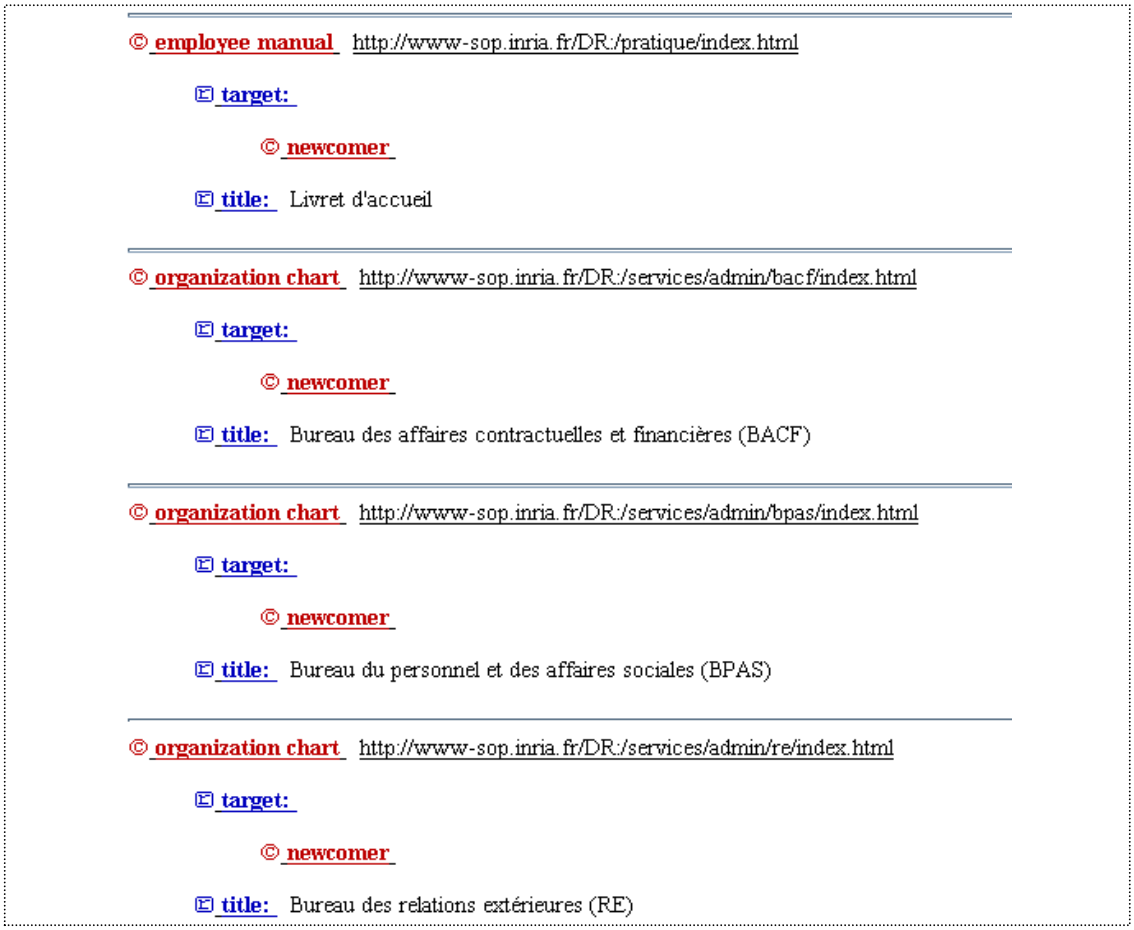


Figure 63 Result displayed in English

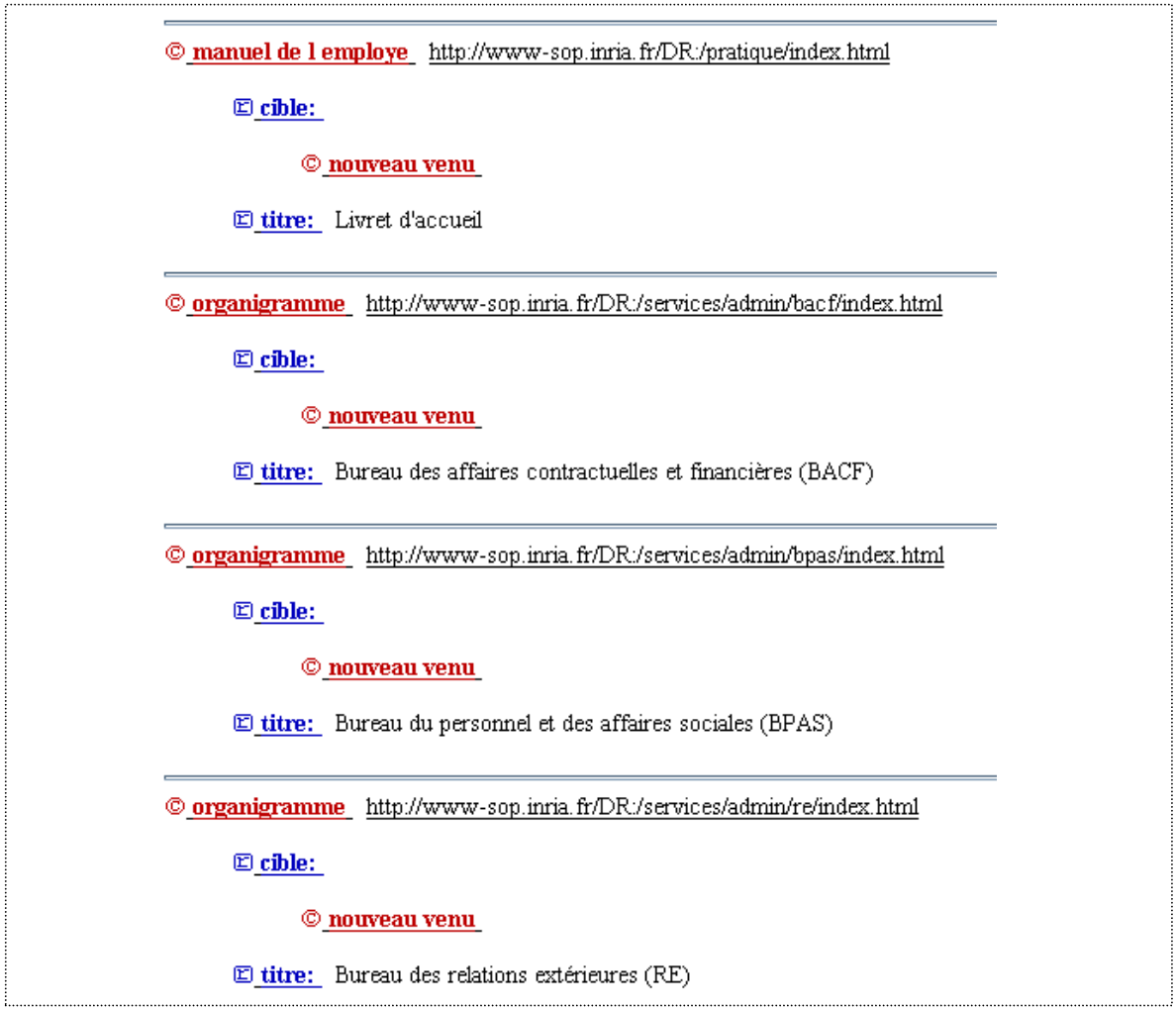


Figure 64 Result displayed in French

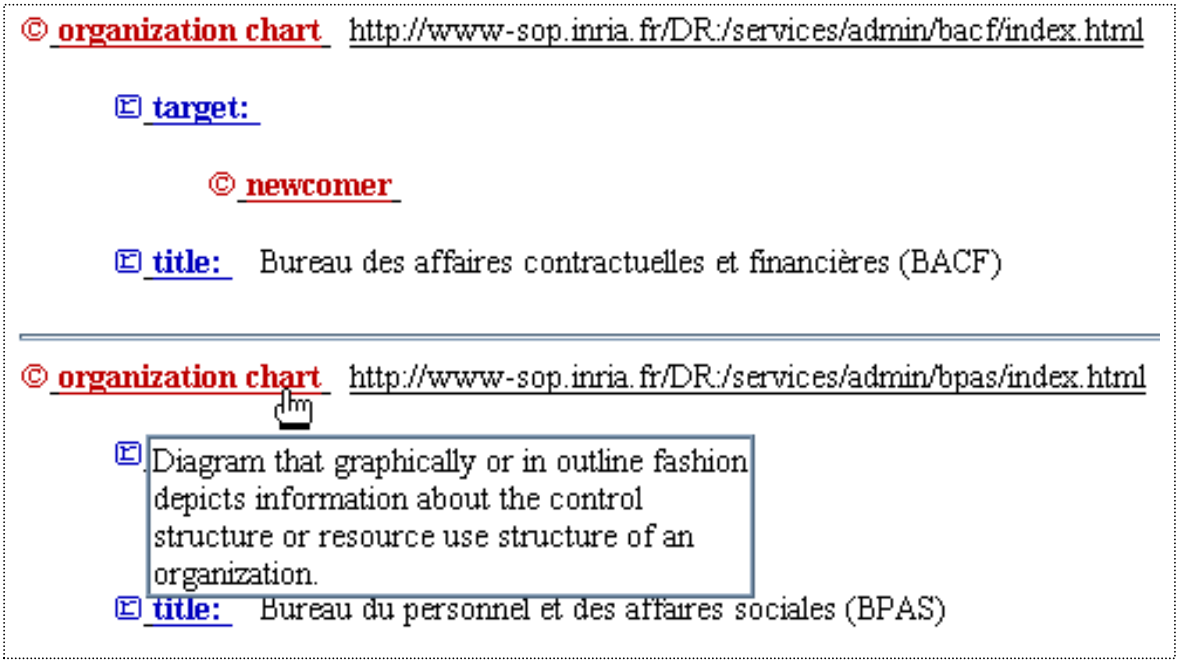


Figure 65 Documenting results

Finally we did say that the ontology relevant aspects are not the same depending on the stakeholder and the context of use. Therefore it makes sense to envisage to use the user profile to filter the access to the ontology and hide the complexity which is still visible in the previous interfaces. In CoMMA we made a try recording preferred entrance points to the ontology in the user profile to propose middle concepts (e.g. person, document, organization) from which the user can start his navigation in the ontology. Just like an alternative to search engines on the web (e.g. Altavista, Google) are the web directories (e.g. Yahoo) we may envisage directories to the memory, the navigation being based on the ontology and the indexing being based on the annotations. Figure 66 shows an extract from a user profile with some entrance points in the ontology. These entrance points personalize the browsing of the ontology by allowing us to customize the middle concepts for each user.

```
<CoMMA:Employee
      rdf:ID = "http://www-sop.inria.fr/acacia/personnel/Fabien.Gandon/">

 <CoMMA:FamilyName>Gandon</CoMMA:FamilyName>
 <CoMMA:FirstName>Fabien</CoMMA:FirstName>
 <CoMMA:HireDate>1999-11-02</CoMMA:HireDate>
 <CoMMA:HasForWorkInterest>
  <CoMMA:ComputerScienceTopic/>
 </CoMMA:HasForWorkInterest>
 <CoMMA:HasForPersonnalInterest>
  <CoMMA:MusicTopic/>
 </CoMMA:HasForPersonnalInterest>
 <CoMMA:HasForOntologicalEntrancePoint>
  <CoMMA:ComputerScienceTopic/>
 </CoMMA:HasForOntologicalEntrancePoint>
 <CoMMA:HasForOntologicalEntrancePoint>
  <CoMMA:Service/>
 </CoMMA:HasForOntologicalEntrancePoint>
 <CoMMA:HasForOntologicalEntrancePoint>
  <CoMMA:Document/>
 </CoMMA:HasForOntologicalEntrancePoint>
 <CoMMA:HasForOntologicalEntrancePoint>
  <CoMMA:Person/>
 </CoMMA:HasForOntologicalEntrancePoint>
 <CoMMA:HasForOntologicalEntrancePoint>
  <CoMMA:OrganizationGroup/>
 </CoMMA:HasForOntologicalEntrancePoint>
</CoMMA:Employee>
```

Figure 66 Ontological entrance points in a user profile

Then a style sheet generates a view of the ontology for a given profile (Figure 67). Therefore the user will not see the top abstract concepts and can start to browse the ontology from concepts that are familiar to him/her (Figure 68) refining or broadening notions (Figure 69). Once a given notion is selected, the system generates automatically short queries among which the user can choose (Figure 70). The results are the indexed documents for which an annotation exists and matches the short query.

Machine learning techniques are also envisaged to identify frequently used concepts in order to improve navigation and result presentation as well as preferred term to ease disambiguation.

Figure 67 Customized directory view of the ontology

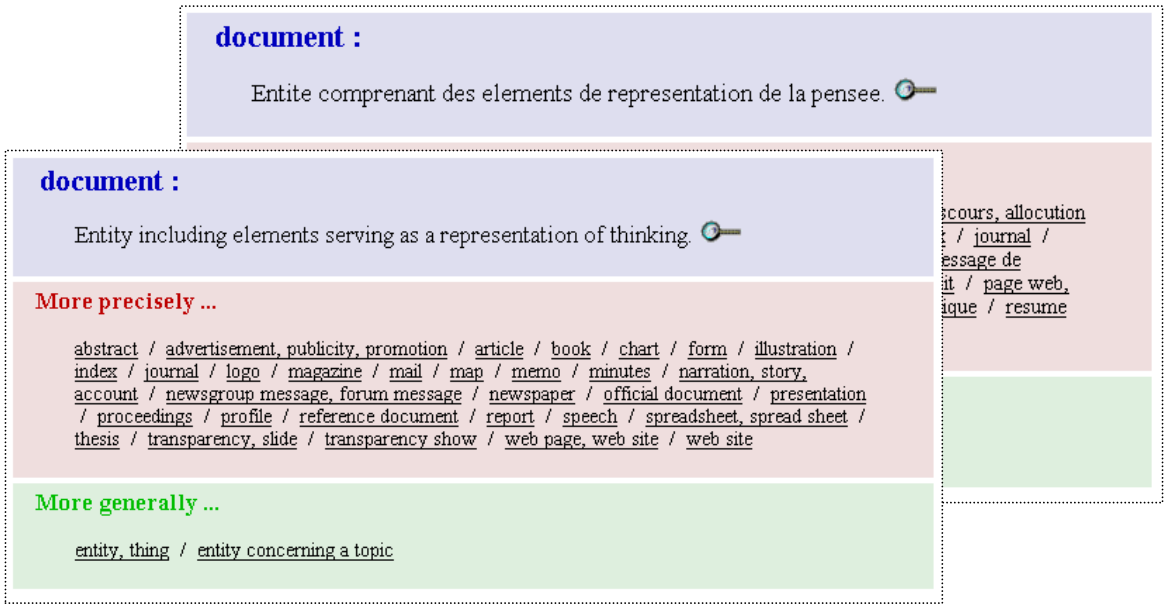


Figure 68 Entering the ontology

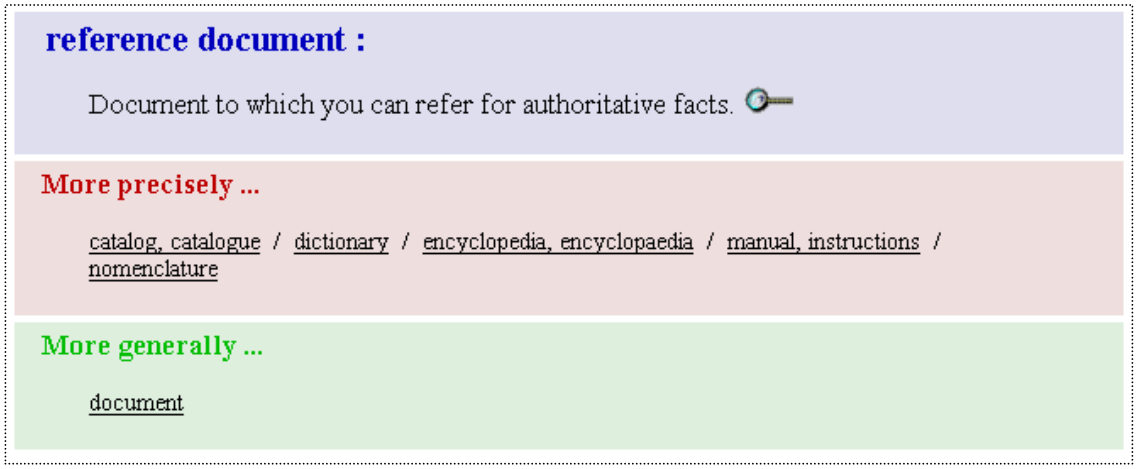


Figure 69 Browsing the directory

Figure 70 Automatically generated simple queries

Figure 71 Indexed document as a result

The problematics of the exploitation of ontologies in interfaces underlines the importance of semiotics consideration in ontology engineering. Interfaces have the unenviable role of bridging the gap between conceptualizations explicit and captured in ontologies and day-to-day use of signs to denote concepts with unavoidable ambiguity and fuzziness. A user does not mobilize the whole conceptualization each time he/she communicates, therefor a system must not impose to a user to handle the whole ontology each time there is an interaction. Secondly as paradoxical as it may seems the ambiguity is vital to access the ontology. The ontology is a neatly formalized theory but the access ways to the ontology must take into account fuzziness and ambiguity, they must capture it so that it can be taken into account in interactions with the user. Ambiguity and changes should be modeled and captured just like any domain, to be exploited in interfaces with the user.

The ontology is at the interface between a symbolic system in its virtual world and cognitive agents in their real world. Different types of interactions and users implies different forms of access and different views of the ontology. The very simple fact of choosing labels in an ontology introduces the ontology in the field of interfaces. Thus interface and ontological problems must be tackled in parallel.

6.5 Evaluation and discussion

6.5.1 Criteria used for component evaluation in CoMMA

Problem : evaluation in a global context: it is hard to evaluate an isolated component when its design was influenced by a complete scenario. Need for a complete evaluation but this is costly.

Criteria	Definition
Appropriateness	Degree in which the component represents a relevant and appropriate answer to the different issues addressed by the project.
Usability	Effort required by the user to learn, operate, prepare input and interpret output of a program
User adaptivity	Capability of the system to adapt itself to the user's behavior.
Accessibility	Capability of the system to provide immediate access to the different functionalities
Exploitability	Degree of ease with which the component could be implemented
Pro-activity	Ability of the system to have autonomous goals or behaviors
Explicability	Capability of the system to trace result production.
Versatility	Capability of the system to be used in various situations.
Guidance	Capability of the system to provide assistance to the user.

Table 15 User-friendliness

Criteria	Definition
Interoperability	Degree to which one component communicates or interfaces with another one.
Portability	Ability to transport component from one target environment to another one.
Flexibility	Degree in which the resulting component is adaptable in terms of functionality, structure and context.
Scalability	Capability of the component to be deployed at large scale, or at large problem.
Reliability	Probability that component will not cause the failure of a system for a specified time under specified conditions.
Security	Degree of security guaranteed by the system regarding access, data stored, transactions.
Cost	Capability of the component to provide cheap implementation solutions
Integrability	Ability of the component to work and to communicate with legacy systems [data base, …]

Table 16Deployment

Criteria	Definition
Modularity	Degree in which the resulting component is subdivided in separated parts, or in other words it is a measure for the degree of structure of this application.
Maintainability	Degree to which a component is amenable to change after it has been delivered to end-users.
Documentation	Ability of the component to propose documentation facilities.
Reusability	Degree in which the resulting component contains modules that could be reused with few adaptations.
Extensibility	Capability of the component to facilitate new functionality integration.
Expressiveness	Capability of the component to offer meaning full representation to the user

Table 17Engineering

Criteria	Definition
Time of response	Elapsed time between the end of an inquiry or demand on a computer system and the beginning of the response
Relevancy	Ability of the component to provide meaningful results
Completeness	Ability of the components to provide the set the whole set of expected answers as results.
Consistency	Ability to not provide contradictory and paradox results.

Table 18Efficiency

6.5.2 Evaluation of the appropriateness of O'CoMMA in the project

Appropriateness: The ontology is a keystone of our system since it provides the building blocks for models, annotations and messages, with their associated semantics. Actual keyword-based search engines such as the ones used for web searching are limited to the terminological occurrences of the extensions of concepts: the introduction of ontologies frees us from this restriction by enabling agents to reason at the intensional level. The ontology provides the semantic needed for semantic web technology by formalizing the relevant semantic aspects of the concepts used for annotating, structuring and searching the memory. When evaluating information retrieval techniques, two important indicators are precision and recall:

- Precision indicates the percentage of the retrieved documents that are relevant to the initial user's need. E.g., if we have retrieved 20 documents and 6 can be considered to be matching our needs, then we would say that precision of the retrieval technique on that test is of 30%.
- Recall indicates what percentage of the relevant documents present in the base was actually retrieved. For instance, if there are 70 relevant documents and only 35 of them were retrieved the recall percentage would be 50%.

Ontology-based annotation by structuring the memory and allowing inferences on its content, is a powerful way to increase precision and recall; for instance the use of the ontology enables to reason at intensional level and thus reduces the noise (improve precision) while the use of taxonomic links enables the system to retrieve information that would not have been found if the tests were only at the 'term level'.

Ontologies are also needed for the models: they provide the conceptual vocabulary to describe the organizational state of affairs and the users' profile. The industrial partners of the project are now aware of the value of their memory and the fact that models have a role to play in this application. In CoMMA they constitute a snapshot of the organization and users characteristics exploited by the information system for supporting corporate memory activities involved in the new employee scenario and the technology-monitoring scenario.

Usability: Ontology usability can be considered from two points of view. From the user point of view the ontology does improve the system behavior and effectiveness. One condition, however, is the development of suited interfaces to make that conceptual structure transparent all along the use of the system. From the designer point of view they introduce efficient coding standards and high-return and high-performance techniques. Ontology-based design does ease the integration phase by coupling components at a high level. However the additional design burden can be prohibitive if it is not thoroughly planned, controlled and restricted to effective needs.

Adaptability: We encountered several problems with the user interface in the first trial: they led us to say that ontology-human interaction needed an intermediary layer for a terminological alignment between the user and the system: we need to explicitly represent the terms and their links with the concepts. That is why we included the terminological level inside the ontology to allow the system to take into account multilingual interfaces, ambiguity in terms, synonymous... This should enable the system to adapt to different users, contexts and uses. The adaptability maintenance however also means maintenance cycles on the ontology that may come to be a heavy recurrent burden.

Accessibility: One of the wishes that came from the end users is to reduce the complexity of the ontology. Especially the top level introduces some highly philosophical distinctions and some abstract concepts. The end-users expressed the wish of simplifying these levels. The visualization complexity should not be a reason for flattening an ontology, and these intermediary levels are important for checking the soundness and for query generalization. The best way to tackle this problem is to hide the complexity through ergonomic interfaces. An ergonomic and pedagogical representation interface is a critical factor for the adoption of the ontology by the users; if the user is overloaded with details or lost in the meandering of the taxonomy (s)he will never use the system and the life cycle of the ontology will never complete a loop. In the CoMMA project, we are investigating this problem and developing a tool for annotation that should also enable us to manipulate the ontology. Even if results from the first prototypes show that the ergonomics issues are far from being solved we did show that XML technology and especially the XSLT style sheets can improve the navigation and the appropriation of the ontology by users.

Explicability, Expressiveness and Documentation: The ontology captures the formal semantics and includes natural language to explain meaning of concepts. The first aspect enables agents to reason at the intensional level, disambiguates exchanges, improves search by augmenting expressiveness of the language for annotating and querying and the precision of expressions (compared to ambiguous terms of keyword plain text search). The final formal version of the ontology is documented by the natural language definitions, comments, remarks, that are exploited by users trying to appropriate the ontology, it is intelligible both to computers and humans. This plays an important role in documenting the querying and result interfaces making them more intelligible.

Versatility and Reusability: The resulting ontology has more or less three layers which are interesting to consider for versatility and reusability concerns:

- A very general top that roughly looks like other top-ontologies
- A very large and ever growing middle layer that tends to be divided into two main branches: one generic to corporate memory domain (documents, organization, people...) and one dedicated to the topics of the application domain (telecom: wireless technologies, network technologies...)
- An extension layer which tends to be scenario and company specific with internal complex concepts (trend analysis report, new employee route card...)

The top layer is extremely abstract and general and therefore potentially highly reusable. The middle layer generic corporate memory part is reusable in the context of any other corporate documentary memory. The topic dedicated middle part is potentially reusable in the context of the same application domain. The extension layer will change as soon as the company or the scenarios are changed. Beware, the reusability of a part does not mean that it won't require adaptations and updates; it only means that the part can be used as a starting point for a new application in order to save time.

Extensibility: Extensibility is an intrinsic characteristic of ontologies where notions can be subsumed by new more general notions and/or can be specialized by new more specific concepts. The example of CSTB extension tables given before shows how such a process of extension can be achieved.

Interoperability: The ontology provides the semantic grounding for the agent-agent, user-agent and user-user interactions. The whole annotation and querying system relies on the fact that the ontology provides a *non-ambiguous shared conceptual vocabulary* to describe the resources and express the patterns of searched information. The whole speech act theory used for the FIPA ACL (Agent Communication Language) messages exchanged is based on a shared ontology (FIPA ontology and CoMMA speech acts ontology). The shared ontology is therefore a keystone of interoperability in the system.

Feasibility, Scalability and Cost: Compared to the Web, a corporate memory has a more delimited and defined context, infrastructure and scope: the corporation. The corporate community is sharing some common global views of the world (e.g.: company policy, best practices) and thus an ontological commitment is conceivable to a certain extend. The work of building an ontology is a tough one (see methodology part): it is extremely time consuming and the ontological commitment needed from the users is difficult to obtain even in a small group, and becomes more difficult as the commitment concerns larger communities. The cost is especially high due to the lack of integrated development platforms for ontology engineering. Finally the ontology evolves in prototype cycles slowly refining and ever changing. The ontology in itself can grow without major problems, but the scalability to larger projects or communities raises serious time and logistic concerns. The precision needed for the ontology and the available resources have to be considered in feasibility studies before any project is started.

Maintainability & volatility: A first draft of the ontology was a good step for feasibility study and first prototypes, but refining, validation and checking work is heavy and it comes with no surprise that the prototype life-cycle is time consuming. Reviews of the ontology are also triggered by feedback from trials, end-user's complaints about what is missing, or what has not been conceptualized or formalized properly. *An ontology is a living object*, the maintenance of which has consequences beyond its own life-cycle: it has an impact on everything that was built upon it. A software where the ontology was hardwired has to be versioned, knowledge base consistency has to be maintained... Therefore, although the problem of the ontology evolution itself is a hard one, one should consider the fact that ontologies provide building blocks for modeling and implementation. What happens to the elements that were built thanks to these building blocks when a change occurs in the ontology? Deletion and modification obviously raise the crucial problem of consistency and correctness of the annotation base. But an apparently innocuous addition of a concept also raises the question of the annotations using a parent concept of the new concept and that could have been more precise if the concept had existed when they were formulated. The question is: should we review them or not? These problems are obviously even more complex in the context of a distributed and heterogeneous system. The development of tools supporting ontology engineering and life-cycle is a vital condition for making maintenance and evolution realistic and therefore for making ontology a credible software design option.

6.5.3 Evaluation of the technology used to implement O'CoMMA

Usability, Versatility and Documentation: We formalized the ontology in RDF Schema. RDFS is an XML language for exchanging schemas (ontologies) on which the annotations are based. In the context of a semantic corporate web it is interesting to use such a standard to exchange the ontology between agents and to use RDF to annotate the documents in the memory.

When formalizing in RDF, the natural language and informal aspects have not been lost, and using XLST style sheets we kept the informal views.

Adaptability: The terminological level in RDF and the XSLT style sheets used for interface and documentation purposes have proved to be real assets. They allow different views for different users/contexts/uses with alternative navigation facilities.

Cost: The whole set of tools used for the RDF and RDFS management is available online for free and CORESE is developed by ACACIA.

Expressiveness: One of the first problems encountered was the redundancy of information that may appear. For instance, annotating a document as multi-modal is redundant with the fact that it is annotated with the different modes it uses. So we decided that the multi-modal concept was not a basic concept and that it should be a 'defined concept', that is a concept derived from other existing concepts where possible. However the notion of defined concept, does not exist in RDFS, and it requires an extension of the schema as proposed by ACACIA in DRDFS [Delteil *et al.*, 2001]. The same applies to unstable or fuzzy concepts, for instance a 'Newcomer': how long are you a new comer in a company ? The definition could change even inside a project involving different companies. These concepts have to be defined based on another information: in our example it could be the hiring date. These choices also arise when formalizing, where sometimes a notion, first formalized by a concept, can become formalized by a relation, or by an inference... and vice-versa. For instance, the first formalization of the notion of 'colleague' by a concept was changed into a relation. And then, considering the enterprise model, it appeared that this relation would not be used for annotation but that it would more likely be inferred from what can be described in the state of affair (Mr. X and Ms. Y belong to department D therefore there is a 'colleague' relation between X and Y).

From these first limitations and the forthcoming functionality to be implemented, we identified the need for inferences, so we extended RDFS to make explicit characteristics of properties useful for inferences (transitivity / symmetry / reflexivity) and we implemented a rule language in XML with the corresponding rule engine.

6.5.4 Evaluation of ontology-based semantic search engine approach

Appropriateness: In order to infer over annotation bases, ACACIA had developed CORESE, a prototype of a search engine in JAVA enabling inferences on RDF annotations by translating the RDF triples to Conceptual Graphs (CGs) and vice versa. CORESE is appropriate in the sense that it was available since the beginning and enabled us to quickly develop mockups and prototypes handling the ontology in RDFS and the RDF annotation that structure the memory.

Modularity and Reusability: CORESE is not only a prototype of search engine, but it is also engineered to provide an API that is used in CoMMA for implementing the behavior of the agents handling the ontology and the annotations. Thus the technical capabilities of manipulating an annotation base can be included in virtually any application written in JAVA.

Portability, Interoperability and Cost: CORESE is entirely written in Java using the free API Notio to handle CGs. It combines the advantages of using the standard RDF language for expressing and exchanging metadata, and the query and inference mechanisms available in CG formalism. Among Artificial Intelligence knowledge representation formalisms, CGs are widely appreciated for being based on a strong formal model and for providing a powerful means of expression and very good readability.

Scalability, Reliability: The Notio API upon which Corese is built provides an implementation-independent interface for manipulating Conceptual Graphs. A key feature of Corese is the matching between a query and a target graph. The Notio graph matching operation which is quite powerful with small-sized graphs, is not usable when the target graph contains a sizeable quantity of information (e.g. more of one minute with a target graph of 50 relations). Moreover, Corese is dedicated to reasoning upon RDF data translated into conceptual graphs, RDF relations being binary ones. The graph-matching algorithm of Notio has then been specialized and improved in Corese. To summarize, four improvements have been made:

- by using heuristics to avoid a combinatorial explosion when exploring the target graph,
- by performing a connected sorting of the query graph,
- by using a cache to accelerate the process,
- by specializing the graph matching algorithm to binary conceptual graphs.

The Corese answer time now averages out to less than one second. In particular, the new graph matching operation of Corese enables to search upon the CoMMA ontology. For instance, a query made of 4 concepts and 3 relations about the CoMMA ontology graph that contains more than 400 concepts and 2500 relations, is answered by Corese in 2 seconds (whereas Notio fails).

Documentation: CORESE, being developed in Java, complies to the JavaDoc standard and therefore comes with the complete documentation of its API in HTML format. There also exists a working document on the query language.

6.5.5 Evaluation of semantic search engine underlying technology

Appropriateness: The memory is, by nature, an heterogeneous and distributed information landscape facing the same problem of information retrieval and information overload than the Web. The approach of the semantic Web is extremely well suited where the semantics of documents is made explicit through metadata and annotations to guide later exploitation. XML becoming an industry standard for exchanging data, the industrial partners of CoMMA appreciate the fact that it is used to build the structure of the memory. Software agents must have the ability to acquire useful semantic information from the context of the world they evolve in to quickly become intelligent actors in those spaces. Annotated information worlds are, in the actual state of the art, a quick way to make information agents smarter. With the corporate memory becoming an annotated world, agents use the semantics of the annotation and through inferences help the users exploitation of the corporate memory. RDF (Resource Description Framework) and its XML syntax allows the resources of the memory to be semantically annotated. The memory can then be considered and exploited as a semantic corporate Web.

Interoperability, Portability: XML is a standard description language recommended by the World Wide Web Consortium for creating and accessing structured data and documents in text format over internet-based networks. Its simple syntax is easy to process by machine, and has the attraction of remaining understandable to humans. XML makes it possible to deliver information to agents in a form that allows automatic processing after receipt and therefore distribute the processing load over the MAS. It is also an industry standard, and therefore a good candidate to exchange data and build a cooperation between heterogeneous and distributed sources in a corporate memory.

Flexibility, Adaptivity and Extensibility: XML is extensible in the sense that one can define new tags and attribute names to parameterize or semantically qualify data and documents. Unlike HTML, XML tags describe the structure of the data, rather than the presentation. Content structure and display format are completely independent. The eXtensible Style sheet Language (XSL) can be used to express style sheets, which have document manipulation capabilities beyond styling. Thus a document of the corporate memory can be viewed differently and transformed into other documents to adapt to the need and the profile of the agents and the users while being stored and transferred in a unique format. The ability to dissociate structure content and presentation enables the corporate memory documents to be used and viewed in different ways. RDF uses a simple data model expressed in XML syntax to represent properties of Web resources and their relationships. It makes no assumption about a particular application domain. The annotations are based on an ontology and this ontology can be described and shared and extended thanks to RDF Schema. RDF Schema is related to object models (Classes, Properties, Specialization,…), however properties are defined independently from classes and multi-inheritance as well as multi instantiation are possible.

Maintainability and Modularity: The set of elements, attributes, entities and notations that can be used within an XML document instance can optionally be formally defined in a document type definition (DTD) embedded, or referenced, within the document. The main reason to explicitly define the language is that documents can be checked to conform to it. Therefore once a template has been issued, one can establish a common format and check whether or not the documents put in the corporate memory are valid and thus maintain its coherence and its structure. XML Schema is going to replace DTDs using an XML syntax and enabling typing of documents. Modularity is reached through namespaces to qualify the origin of tags and attributes that can be imported from virtually anywhere.

Integrability: A legacy application is a program or a group of programs in which an organization has invested time and money and usually it cannot be changed or removed without considerable impact on the activity or the workflow. Just as an important feature of new software systems is the ability to integrate legacy systems, an important feature of a corporate memory management framework would be the ability to integrate the legacy archives, especially the existing working documents. Since RDF allows for external annotations, existing documents of the corporate memory may be kept intact (word processor document, spreadsheet, image, etc.) and annotated externally.

Usability, Exploitability and Accessibility: Inference and query mechanisms have been developed and tested, and are available to manipulate CGs. Using the mapping from CG to RDF we have been able to quickly test our ideas and hypotheses on the feasibility and exploitability of a semantic corporate web. Moreover, there exists a real adequacy between the two models: RDFS classes and properties smoothly map onto CG concept types and relation types. More precisely, RDF statements are mapped to a base of CG facts, the class hierarchy defined in an RDF schema is mapped to a concept type hierarchy in the CG formalism and the hierarchy of properties described in the RDF schema is mapped to a relation type hierarchy in CG. The concept type hierarchy and the relation type hierarchy constitute what is called a support in the CG formalism: they define the conceptual vocabulary to be used in the CGs for the considered application. In CORESE, queries are RDF statements with wildcard characters to describe the pattern to be found and the values to be returned. The RDF query is translated into a CG that is projected onto the CG base to isolate any matching graph and extract the requested values that are then translated back into RDF. Thus CORESE

allows agents to mine the corporate memory through its annotations. The projection mechanism takes into account the hierarchies and specialization relations described by the CG support obtained from the RDF schemas, thus the semantic search improves precision and recall thanks to exact typing and subsumption semantics. It also allows for tuning the matching processes, enabling approximate matching or generalization.

RDF Expressiveness: In the framework of CoMMA, the expressiveness of RDFS appears too much limited to represent the whole ontological knowledge of the corporate memory. Axiomatic knowledge - concept formal definitions, algebraic properties of relations, domain axioms - is crucial for intelligent IR on the Semantic Web and the need for inference rules clear: they are the key to discover implicit knowledge in the Web resource annotations and they enable IR to be independent of the point of view adopted when annotating. These remarks are also relevant for a corporate memory considered as a corporate semantic Web.

Part of the ontological knowledge of a domain is captured through axioms. They have to be taken into account by the matching function of a query against a document annotation – just like the subsumption relations between concepts. Rules are viewed as the (explicit) factorization of knowledge that is implicit in numerous document annotations. They enable the addition of this knowledge beside each annotation when matching a query against it so that the answer to the query does not depend on a strict matching of the points of view of the annotation's and query's authors. As an example, stating that a *cooperating_with* relation is symmetric allows to ignore the ordering of its arguments when building a query. Rules are basically dedicated to the specification of algebraic properties, e.g. the symmetry of *competitor_of*, the transitivity of *containing*, and the specification of inverse relations, e.g. being the *author_of* a publication is just the reverse of being the *publication_of* an author. Although these are very simple rules, they are very helpful in enabling a query formulation without knowledge of the arbitrary point of views adopted when annotating the documents. Ontologies may be further enriched by more sophisticated rules, e.g. a rule may state that if a person is an employee of a department, he is an employee of the organization the department is part of.

The definition of concepts enables reasoning over concepts. Especially in Information Retrieval, it ensures further expressiveness for queries. When matching a query against annotations, defined concepts may be matched against their definitions (i.e. necessary and sufficient conditions for an instance to belong to these concepts): a publisher is an organization that publishes something, two people are coauthors if they are authors of the same document. In addition to concept definitions (i.e. necessary and sufficient conditions), it may be interesting to express necessary (resp. sufficient) conditions associated with a concept: a person is a possible participant in a conference if he is the author of a paper published in the conference proceedings, a person is interested in a topic if he writes a paper on that subject, etc.

When compared to Description Logics (DL), or Conceptual Graphs(CG), RDF(S) does neither enable to describe explicitly class or property definitions, nor axioms. As a result, ACACIA proposed an extension of RDF(S) with class and property definitions and axioms. This extension is called DRDF(S) [Delteil *et al.*, 2001] for Defined Resource Description Framework. More generally, DRDF(S) enables us to express contextual knowledge on the corporate memory. Because the RDF policy consists of letting anybody free to declare anything about any resource, the knowledge of by whom and in which context a special annotation has been stated is crucial: DRDF(S) enables to assign a context to any cluster of annotations. The representation of class and property definitions and axioms is based on this general notion of context. Our approach of RDF(S) is underlain by the existing mapping between RDF(S) and the CG model: DRDF(S) is based on features of the CG model that provide further representation capabilities.

```
<cos:rule>
    <cos:if>
       <rdf:RDF>
           <CoMMA:OrganizationalEntity>
             <CoMMA:Include> <CoMMA:Person rdf:about="?x"/> </CoMMA:Include>
             <CoMMA:Include> <CoMMA:Person rdf:about="?y"/> </CoMMA:Include>
           </CoMMA:OrganizationalEntity>
       </rdf:RDF>
    </cos:if>

    <cos:then>
       <rdf:RDF>
          <CoMMA:Person rdf:about="?x">
            <CoMMA:Colleague> <CoMMA:Person rdf:about="?y"/></CoMMA:Colleague>
          </CoMMA:Person>
       </rdf:RDF>
    </cos:then>
</cos:rule>
```

Figure 72 Rule defining Colleague relation

Figure 73 Some rules of CoMMA displayed through XSLT style sheets

Figure 74 Querying the base with the defined relation 'Colleague'

6.5.6 Conclusion on evaluation

The ontology component represents the keystone of the CoMMA system, the “guarantor” of the complete semantics of the target corporation. It is a must to support the semantic web technologies. Ontology is perfectly extensible, quite reusable if some adaptations are made, and is a major factor of the system interoperability at the semantic level.

The other side of the coin is that the ontology design and deployment is really time-consuming and generates high costs. The maintenance is difficult and has a lot of consequences on the whole system integrity. Moreover, the relations between the ontology and the user are a major area of concern. The implementation of a Graphical user interface that guarantees the transparency, the accessibility of the ontology and the access adaptability is a critical factor; important progresses have been done with regards to this point.

RDF(S) coupled with XML style sheets provides interesting and cheap support to deal with ontologies. Adding inference mechanisms could compensate the RDF problem of expressiveness.

Bachimont [2000] decomposes the ontology modeling process "in three stages, corresponding to three commitments. First, the semantic commitment specifying the linguistic meaning of concepts. Second, the ontological commitment specifying their formal meaning. Finally, the computational commitment specifying their effective computer-based use." Much work is needed to help explicit, represent and preserve the intensional semantic structure of the computational level. Since the ontology is motivated by an intended use, this use has to be made explicit and it will be of great help in the ontology recycling and reusing process. If the new generation of AI agents is to be based on an explicit conceptualization, this must not be limited to the knowledge exchanged currently, it must include the action performed (inferences) with both their intension and intention. Unfortunately, this aspect is too complex and unexplored to be included in the workplan of CoMMA.

To summarize, this experience in CoMMA gave rise to several expectations and to be able to manage, share and discuss the growing ontology, we would definitively need an integrated environment with:

- improved interfaces for representation, navigation and manipulation of ontologies;
- tools for natural language processing, based on statistics, linguistic rules, heuristics... to ease and semi-automate the process of text corpus analysis, to manipulate and exploit the extensive part of textual resources;
- facilities for applying the results from theoretical foundations of ontologies and for helping ontologists check their ontology;
- tools to manage the versioning of the ontology and of all that has been built upon it (annotations, models, inferences...) and to capture the design rationale.

Ontologies are definitely a powerful conceptual tool but the complexity of their design and maintenance makes compulsory to develop complete "workshop software" to assist ontologists at each stage and transition of the construction and maintenance cycles enabling the actual research results to scale-up to the scope of a real company application.

As far as O’CoMMA is concerned, CoMMA will focus on the first of these four points. We also foresee some adaptation of the ontology (especially the domain topics part) to adapt to the introduction of a new partner in CoMMA. This work has already started.

The first draft of the ontology is a good step for feasibility study and first prototypes. However we will have to review completely the ontology and to apply checking techniques described in the first part about the state of the art. We will also exploit the feedback from first trial to identify what is missing, or what has not been conceptualized or formalized properly. One of the big challenges is to manage modularity, extensions and versioning of the ontology: we shall explore the means offered by namespaces mechanisms coupled together with the multi-agent paradigm. To be able to manage, share and discuss the growing ontology, we will have to improve interfaces and representation systems. Finally, the results and work done must be the subject of a dissemination plan.

CONCLUSION

Actual keyword-based search engines such as the ones used for web searching are limited to the terminological and extensional aspects of concepts. The introduction of semantics based annotations and models frees us from this restriction by enabling the CoMMA system to reason on information and to adapt to its environment. We presented here the state of the art we used and our experiences in building the O'CoMMA ontology designed for a corporate memory management system aimed at enhancing newcomer integration and technology monitoring. We proposed an hybrid approach combining the top-down, middle-out and bottom-up classical approaches that we believe to be complementary perspectives of a complete methodology.

Ontologies are powerful design tools for knowledge management systems. However development and maintenance costs, if not controlled, can easily become prohibitive. For this reason, in the current state of the art, and with the existing tools, ontological engineering should be used carefully and with a very well planned approach. Our idea is to start with a quickly designed and limited ontology aiming at "80% of results and 20% of complexity". Then, even a limited ontology should improve performances enough to convince stakeholders to invest themselves more in the process and start a virtuous circle where a better ontology brings better results to stakeholders and better results encourage stakeholders to maintain and improve the ontology. The return of experiences we gave in this report is a contribution to ontology feasibility and methodological studies. In addition we strongly believe that natural language processing tools should be included in the data-collection and terminological stages in order to enable ontology engineering to scale-up to large corpora of documents. As a result, O'CoMMA is an ontology partially reusable for other projects, as shown by the examples of modifications required by the introduction of a new partner in the consortium. The structure of the ontology shows which parts can be reused, and what adaptation is needed depending on the changes in the scenarios and the application domain.

Ontologists would definitively need a comprehensive integrated set of tools, to support the complete ontology life-cycle at each stage and for each transition. This is vital for the development of a real-scale ontology-based system. From that point of view, the work done in CoMMA on the use of XML technology for an ontology-based memory and the current development of tools for ontology manipulation and exploitation, especially for querying and annotation, is a real contribution to the field.

CoMMA is interested in a system highly flexible, modular and adaptive. The multi-agent systems are, in this respect, very well suited. However to achieve a fine adaptation and customization to an organization environment and the stakeholders characteristics, we have to provide the system with models of such aspects. The ontology approach enables to define the needed primitives to describe explicit models of the reality that will then be exploited by agents in their interactions. The core idea of the CoMMA approach is independent of the scenario itself: only the content of the ontology and the inferences will be tuned to the application specificity. Therefore the whole modeling approach described here is reusable. CoMMA provides an insight of the environment to the system through an organizational model and user profiles described with ontological primitives. We explained and showed example of enterprise models where, in each case, the aspects relevant for the scenarios are captured to guide the system in its global capitalization of knowledge. We also showed that, on the other hand, the local adaptation and customization to each user implies the description of corresponding user's profiles aspects relevant for the application scenarios. Finally, we stressed the importance of user-friendly interfaces to bridge the gap between the conceptual level and stakeholder's day-to-day concerns. Presentation and representation means are a key need for user's acceptance.

The overall modeling approach proposed in CoMMA shows how knowledge representation techniques, enterprise modeling and user modeling can improve the performances of corporate memory systems. We acknowledge the complexity and costs that can arise from these approaches, but we showed with the CoMMA experience that a focused design (based on scenario analysis in our case) and a prototype-life cycle can successfully start and engage a corporate memory management solution in a virtuous life cycle which is the only way for a memory to be maintained and durable, where a better ontology brings better results to stakeholders and better results encourage stakeholders to maintain and improve the ontology.

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Appendix A. LEXICON VIEW OF THE ONTOLOGY

Term	Natural Language definition
A.I.	Branch of computer science concerned with making computers behave like humans.
A.I.F.F.	Data File Format of audio documents encoded in Audio Interchange File Format.
abstract	Document corresponding to a summary of another document.
academic	Activity of education and/or research usually affiliated to academic institution.
account	Document corresponding to an account describing incidents or events.
acoustics	12
activity	Entity representing a type of voluntary action.
activity able entity	Entity that can have an activity.
addition	Corporate Memory Event corresponding to content added to the memory.
additional topic	Entity representing subjects that hold attention and possibly something one wants to discover. These topics are additional in the sens that they were not introduced or used anywhere else in the ontology but were identified as relevant for document annotation - domain concepts, general subjects...-
address	Address of a location.
administer	Service of supervision and control of the operations or arrangement of an Organizational Entity.
administer	Relation denoting that an Entity -Domain- regulates the operations of an Organizational Entity -Range-.
administration	Service of supervision and control of the operations or arrangement of an Organizational Entity.
administration able entity	Entity that can administrate another.
administrator	Professional who is responsible for managing its organizational affairs. Administrator may or may not also be required to manage people. If so, then they are also Managers.
advertise	Activity consisting in making something known in order to sell it.
advertisement	Activity consisting in making something known in order to sell it.
advertisement	Document of a public announcement, especially to proclaim the qualities or advantages of some product or service so as to increase sales.
advertising	Activity consisting in making something known in order to sell it.
aerodynamics	13
agriculture	Science of cultivating the soil, producing crops, and raising livestock; farming.
AI	Branch of computer science concerned with making computers behave like humans.
AIFF	Data File Format of audio documents encoded in Audio Interchange File Format.
air pipe	235
algebra	the mathematics of generalized arithmetical operations.
alternative document	Relation denoting that a document has other occurrences eg. different format, different URL...
American	English spoken by the natives of American.
analog format	Storage format based on continuous data.
analysis	Branch of mathematics involving calculus and the theory of limits, sequences, series, integration and differentiation.
animation	Dynamic Image that appears to move.
annual report	Report of the formal financial statements and operations, issued by a corporation to its shareholders after its fiscal year-end.
anything	Whatever exists animate, inanimate or abstraction.
aquaculture	Science, of cultivating marine or freshwater food fish or shellfish, such as oysters, clams, salmon, and trout, under controlled conditions.
architecture	63
archivist	Technical monitoring actor responsible for library activities.
area referent	Technical monitoring actor responsible for an expertise area and who has a group of contributors observers to manage.
art	Activity through which people express particular ideas, the making of what is expressive or beautiful.
article	Document corresponding to a piece of writing on a particular subject and which purpose is to fully realize a particular objective in a relatively concise form e.g.: demonstrate something.

artificial intelligence	Branch of computer science concerned with making computers behave like humans.
artificial language	Language that has been explicitly developed at a specific time, rather than evolving naturally over time through use by a community. It is usually designed for a specific purpose.
asphalt	25
assembly language	Low-level Language that contains the same instructions as a Machine Language, but the instructions and variables have names instead of being just numbers.
assist	Denotes that Tutor assists a Newcomer.
assistant	Professional that contributes to the fulfillment of a need or furtherance of an effort or purpose.
association	Formal group of individuals who have an interest, an activity, or a purpose in common.
attribute	Predefined entities characterizing other entities.
audio CD	CD where the Documentary Element uses Audio Perception and is recorded using hi-fi music industry format.
audio compact disc	CD where the Documentary Element uses Audio Perception and is recorded using hi-fi music industry format.
Audio Interchange File Format	Data File Format of audio documents encoded in Audio Interchange File Format.
auditor	Professional performs audit.
auditory	Documentary Perception Mode by hearing.
bad	Value corresponding to a bad feedback given about a consultation
banking	Finance activity concerned with deposits, channeling money into lending activities, providing services for investing money, borrowing money or changing money to foreign currency.
beginning	Starting date/hour of an gathering.
benevolent association	Association which helps a particular group of people in need.
biology	The scientific study of the natural processes of living things.
birth date	Date of birth.
book	Document consisting of a set of pages to be fastened together inside a cover to be read.
booklet	Book (small) with a small number of pages often giving information about something.
brick	25
building	
building materials	25
building product	25
building site	27
building transversal theme	60
business	Activity composed of commercial or industrial activities intended to make profits.
buy	Commerce activity where a person or an organization obtains something by paying money for it.
C.D.	Digital Medium where the Documentary Element is recorded on a optical disc.
C.O.R.B.A.	Common Object Request Broker Architecture, an architecture that enables pieces of programs, called objects, to communicate with one another regardless of what programming language they were written in or what operating system they are running on.
carpentry	231
cartography	
carving	Iconic Representation System producing three-dimensional and usually tangible representations.
casing	222
catalog	Reference document containing an enumeration of things usually linked to a domain or an activity.
catalogue	Reference document containing an enumeration of things usually linked to a domain or an activity.
CD	Digital Medium where the Documentary Element is recorded on a optical disc.
CD audio track	Digital format used for audio track on compact discs.
CD-ROM	CD used for storing computer data.
cellular phones	Telecommunications part concerned with portable radiotelephones.
cement	25
chart	Document corresponding to a visual display of information often intended to show the information more clearly.
chief	Professional whose primary job is to manage other people, directing their work activity. A Manager tells his or her subordinate workers what to do.
civil engineering	17

client	Organization who pays for goods or services.
climatology	18
clock time	Time Entity corresponding to a time of day.
club	Group of individuals with a common purpose or interest who meet regularly and take part in shared activities.
cluster	Organization part grouping projects according to their client type.
coating	233
coating	25
code of conduct	Manual that makes explicit the expectations governing the behavior of those agents subject to it in certain kinds of situations.
cognitive sciences	Topic concerned with the sciences studying cognition.
colleague	one of a group of people who work together.
comments	Textual remark or observation about a document.
commerce	Activity concerned with buying or selling goods or services for a profit.
common object request broker architecture	Common Object Request Broker Architecture, an architecture that enables pieces of programs, called objects, to communicate with one another regardless of what programming language they were written in or what operating system they are running on.
compact disc	Digital Medium where the Documentary Element is recorded on a optical disc.
competitor	Organization having similar activities to an organization and trageting the same markets.
computer algebra methods	
computer analysis	
computer file format	Digital format corresponding to a single collection of computer data or information that has a name.
computer graphics	
computer science	Study of automatic information and data processing methods, and of computers, including both hardware and software design.
computer vision	
concern	Relation denoting that an entity (e.g.: a document, a gathering...) concerns a topic.
concrete	25
conduit	235
conference	Formal Gathering of persons with common interests, esp. professional interests, for the purpose of sharing information and opinions especially through lectures and debates.
confidential document	The diffusion is restricted to a defined community. There are different levels of confidentiality for internal or external diffusion. A document can be composed of confidential parts or not confidential parts (for example: the reference and the abstract can be freely diffused but not the integral text).
consortium	Organization of several Businesses joining together as a group for some shared definite purpose.
consultancy report	Report on studies performed for clients. Most of them are confidential.
consultant	Professional who works with some business in a consulting capacity.
consultation	Corporate Memory Event corresponding to a user seeking information from the memory.
consultation trace	Such an element is created when the user visits a document, and is updated every time he returns to the document.
consulting	Service of providing professional advice or expertise.
contain	Relation denoting that a document includes another one.
contract type attribute	Type of contract.
CORBA	Common Object Request Broker Architecture, an architecture that enables pieces of programs, called objects, to communicate with one another regardless of what programming language they were written in or what operating system they are running on.
corporate memory	An explicit, disembodied and persistent representation of knowledge and information in an organization, in order to facilitate their access and reuse by members of the organization, for their tasks.
corporate memory event	Event corresponding to changes in the Corporate Memory.
corporate policy	Manual that contains the terms of some policy of a particular organization.
corrosion	26
course	Training document containing pedagogical material and usually used by lecturers or teachers as a support of their lessons.
course	Formal Gathering where a Person - lecturer - teaches by giving a discourse on some subject to a group of people students-.
created by	Relation denoting that a Document has been created by an Entity.
creation date	Date the document was created.

customer	Organization who pays for goods or services.
customer type	type of clients to whom the service is addressed.
D.A.I.	Distributed approach of Artificial Intelligence.
D.V.D.	Digital Medium where the Documentary Element is recorded on a optical disc called Digital Versatile Disc or Digital Video Disc.
DAI	Distributed approach of Artificial Intelligence.
data file format	Computer File format dedicated and formatted to be manipulated by a Program.
date	Time Entity corresponding a numbered day in a month, often given with a combination of the name of the day, the month and the year.
deletion	Corporate Memory Event corresponding to content removed from the memory.
department	Thematic grouping of services.
description of a pattern	Textual remarks or explanations about a pattern.
designation	Identifying word or words by which a thing is called and classified or distinguished from others.
development	Service corresponding to analysis, design, implementation and testing of research solutions.
diagram	Chart intended to explain how something works a drawing showing the relation between the parts.
dictionary	Reference used as a point of reference to compare and evaluate quality of products or systems.
dictionary	Reference Document in which words are listed alphabetically and their meanings.
diffusion right	Authorized scope for the diffusion of a document.
digital format	Storage format based on discontinuous data.
digital versatile disc	Digital Medium where the Documentary Element is recorded on a optical disc called Digital Versatile Disc or Digital Video Disc.
digital video disc	Digital Medium where the Documentary Element is recorded on a optical disc called Digital Versatile Disc or Digital Video Disc.
direction	Organization part with a special activity inside the company eg: HR, Project Planning.
discrete event simulation	
distributed artificial intelligence	Distributed approach of Artificial Intelligence.
division	Functional subdivision of a service. It has generally 10 to 25 people.
document	Entity including elements serving as a representation of thinking.
documentary file	Thematic document, regularly updated and made with heterogeneous material (articles, references, synthesis…).
documentary medium	Physical entity through which signals/messages travel as a means for communication.
document attribute	Attribut characteristic of documents.
document orign	Where the document was produced or written.
domain	Domain associated given by the national nomenclature.
door	231
drainage	21
duration	Time Entity corresponding to the length of time that something lasts.
DVD	Digital Medium where the Documentary Element is recorded on a optical disc called Digital Versatile Disc or Digital Video Disc.
DVD-ROM	DVD used for storing computer data.
dynamic image	Image changing over time quickly enough to be noticed.
dynamic systems	
earthenware	25
earth observation	
economic science	30
education	Service of teaching and/or training.
electronic mail	Mail sent in electronic format over a computerized world-wide communication system.
e-mail	Mail sent in electronic format over a computerized world-wide communication system.
employed by	Relation denoting that an Organization has an Employee working or doing a job for it and pays this Employee for it.
employee	Professional who works for an organization in return for financial or other compensation. Disjoint with Self-employed Professional.
employee manual	Manual that officially explains company policies, procedures, and benefits.
employment contract	Relation denoting the Type of the contract that link an Employee to an organization.
encyclopaedia	Reference Document usually rather large and containing many articles arranged in alphabetical order which deal either with the whole of human knowledge or with a particular part of it.

encyclopedia	Reference Document usually rather large and containing many articles arranged in alphabetical order which deal either with the whole of human knowledge or with a particular part of it.
end	Ending date of an gathering
energetic engineering	241
energy	19
engineer	Professional who works in some branch of engineering using scientific knowledge to solve practical problems.
English	Natural Language spoken by the natives of England.
entertainment event	Event occurring primarily to amuse or entertain Persons.
entity	Thing which exists apart from other Things, having its own independent existence and that can be involved in Events.
entity concerning a topic	Entity that can concern a topic.
enveloppe	222
environment	64
equipment	24
event	Thing taking place, happening, occurring and usually recognized as important, significant or unusual.
Excel	Data File Format of a visual document encoded in the format of Microsoft Excel workbook.
Excel format	Data File Format of a visual document encoded in the format of Microsoft Excel workbook.
EXE	Computer File Format of a program that can be executed by a computer.
executable format	Computer File Format of a program that can be executed by a computer.
executive	Professional who holds a high position in some Organization, makes decisions and puts them into action.
extensible markup language	Web Extensible Markup Language enabling the definition, transmission, validation, and interpretation of data between applications and between organizations.
Extensible Markup Language Format	Text Format of a Documentary Element written in eXtensible Markup Language.
external document	Document acquired from an external source and not written in-house.
external people	Professional from an organization but working for another for a limited period of time.
extracted document	Document that can have been extracted from another.
extracted from	Relation designating the document from which the article was extracted.
facade	224
facilities	24
facing	233
family name	The name used to identify the members of a family.
fax number	Fax number of a location.
female	Person of the sex that can give birth.
ferrous metal	25
film	Animation usually shown on a screen - cinema, TV, computer...- and often telling a story.
filtering	
final report	Report concluding and synthesizing the results of a research action or a consultancy contract.
finance	Service concerned with buying, selling, trading, converting, or lending money, in the form of currency or negotiable financial instruments -such as stocks, bonds, commodities futures, etc.-
first name	The name that occurs first in a person s full name.
first visit	Date of the first visit to a document.
floor coating	233
flooring	233
flowchart	Diagram which shows the stages of a process.
food	Service of preparing and/or serving food.
form	Document for structured solicitation of input from a user.
formal gathering	Gathering agreeable to established mode, forms, conventions and requirements, methodical well planned and organized, not incidental, sudden or irregular.
format du Langage de Marqueurs Extensible	Text Format of a Documentary Element written in eXtensible Markup Language.
forum message	Document corresponding to messages displayed on the Internet and devoted to the discussion of a specified topic.
foundations	225
French	Natural Language spoken by the natives of France.
front	224

full time	Contract type of an employee working full-time for an organization.
functional equations	
G.I.F.	Data File Format of a visual document compressed in Graphics Interchange Format.
G.P.R.S.	
G.S.M.	
gathering	Event corresponding to the social act of a group of Persons assembling in one place.
gathering entity	Entity that can participate to a gathering.
general packet radio service	
geographical area	geographical area in which the specific service or technology are developed or exist.
geometry	Branch of mathematics relating to the study of space and the relationships between points, lines, curves and surfaces.
German	Natural Language spoken by the natives of Germany.
GIF	Data File Format of a visual document compressed in Graphics Interchange Format.
given name	The name that occurs first in a person s full name.
glass	25
global system for mobile communications	
good	Value corresponding to a good feedback given about a consultation.
GPRS	
graph	Chart which shows a series of points, lines, line segments, curves, or areas that represents the variation of a variable in comparison with that of one or more other variables.
graphic	Iconic Representation written or drawn, printed or engraved.
graphics interchange format	Data File Format of a visual document compressed in Graphics Interchange Format.
groupable entity	Entity that can be included in an other entity (a group).
group of individuals	Organization Group composed of individuals only.
group profile	Profile concerning a group of people.
GSM	
H.C.I.	Study of human-computer relations with the aim to improve them.
H.T.M.L.	Text Format of a Documentary Element written in HyperText Markup Language.
H.T.M.L.	Web language for hypertext markups.
H.T.M.L. format	Text Format of a Documentary Element written in HyperText Markup Language.
H.T.T.P.	Web protocol for transferring hypertext.
had for participant	Relation denoting that an Organizational Entity participates/participated to a Gathering.
has for activity	Relation denoting that an Entity is carrying out an activity.
has for diffudion right	Relation denoting the diffusion right of a document.
has for favorite annotation	Relation denoting a favorite pattern of a user for annotating resources.
has for favorite query	Relation denoting a favorite pattern of a user for querying the base.
has for internal report number	Internal report number.
has for medium	Relation denoting that a document uses a medium.
has for number	Number associated to a 'numberable' entity.
has for ontological entrance point	Relation denoting a prefered entrance point for browsing the ontology.
has for origin	Relation denoting the origin of a document.
has for perception mode	Relation denoting that a document uses a perception mode -audio, visual, tactile-.
has for personnal interest	Relation denoting that an entity has a personal interest
has for representation system	Relation denoting that a document uses a representation system.
has for storage format	Relation denoting that a document is stored in a given format.
has for work interest	Relation denoting that an Entity has a special work interest.
HCI	Study of human-computer relations with the aim to improve them.
head	Professional responsible for an organization part.
head of department	Professional responsible for a department.
head of division	Professional responsible for a division.
head of laboratory	Professional responsible for a laboratory.
head of pole	Professional responsible for a pole.
head of project	Professional responsible for a project.
head of service	Professional responsible for a service.
high level language	Programming Language that enables a programmer to write programs that are more or less independent of a particular type of computer. Such languages are considered high-level because they are closer to human languages than are Low-level Languages, which are closer to machine languages.
hiring date	The date when the employee was hired.

homepage	Web Page designed to be the main page of a Web site. Typically, the home page serves as an index or table of contents to other documents stored at the site.
home page	Web Page designed to be the main page of a Web site. Typically, the home page serves as an index or table of contents to other documents stored at the site.
house automation	244
HTML	Text Format of a Documentary Element written in HyperText Markup Language.
HTML	Web language for hypertext markups.
HTTP	Web protocol for transferring hypertext.
human	Living Entity belonging to mankind, an individual human being.
human being	Living Entity belonging to mankind, an individual human being.
human-computer interaction	Study of human-computer relations with the aim to improve them.
human resources	Service of administration of people, especially the skills and abilities they have, and the job and position they occupy.
human science	30
hygrothermics	15
hypertext markup language	Web language for hypertext markups.
HyperText Markup Language format	Text Format of a Documentary Element written in HyperText Markup Language.
hypertext transfer protocol	Web protocol for transferring hypertext.
iconic representation system	Documentary Representation System based on icons that perceptually resemble the objects they represent - e.g. the drawing of an apple and a real apple -
illustration	Document corresponding to artworks that help make something clear or attractive.
image	Graphic visually representing an object, a scene, a person... and produced on a surface.
image processing	Analyzing and manipulating images with a computer.
include	Relation denoting that an Entity has as a part another Entity.
independent contractor	Contract type of a self-employed professional who is retained to perform a certain act but who is subject to the control and direction of another only as to the end result and not as to the way in which the act is performed.
index	Document consisting of summary list of other items.
index card	Document for categorising services, applications, company s market operations, etc.. This is a useful way to represent information when the emphasis is put on some specific point of innovation rather than on a very detailed description of the single service, application or fact.
indexical representation system	Representation System based on indices that are physically connected with the object they represents - e.g. smoke and fire.
indication	Textual signs/clues pointing to the location e.g.: "in the cupboard of the rest room".
individual profile	Profile concerning one individual.
inert entity	Physical Entity that cannot be alive.
informal gathering	Gathering without official forms - of clothing, behavior, speech - not according to conventional, prescribed, or customary forms or rules hence, without ceremony not officially recognized or controlled, usually having or fostering a warm or friendly atmosphere, especially through smallness.
information form	Form for engineers and researchers to share their (informal) information.
information form source	Source of the information.
inspector	Professional performs audit.
installations	24
instructions	Reference Document which gives you practical instructions on how to do something or how to use something, such as a machine.
insulation	232
insulator	25
insurance	Service of providing financial and material protection to clients in the event of sickness, death, natural disaster, loss, theft, lawsuits, etc.
integration process actor	A Person playing a role in the newcomer integration process.
interactivity	Study of sensory dialog that occurs between a human being and a computer system.
interest able entity	Entity that can show interests in some topics.
intermediate report	Punctual report produced at the end of each step of a research action or a consultancy contract (state of the art, experiment…).
internal document	The document was produced in-house..
international organization	Organization Group of international scope, that is, one which has substantial operations, physical facilities, or substantial membership in multiple countries.
International Standard Book Number	The International Standard Book Number (ISBN) is a system of numerical identification for books, pamphlets, educational kits, microforms, CD-ROM and braille publications.

Internet	A global network connecting millions of computers.
intern mail	Mail transmitted via an Organization internal post system.
interview	Meeting face to face to ask a series of questions usually in order to obtain information from the interviewee. There is usually one interviewee - person who is asked questions - and one interviewer - person who asks the questions but there may be more.
ISBN	The International Standard Book Number (ISBN) is a system of numerical identification for books, pamphlets, educational kits, microforms, CD-ROM and braille publications.
is interested by	Relation denoting that an Entity is interested in a topic.
ISRN	Identification code for reports.
ISSN	Standardized international code which allows the identification of any serial publication.
ISSN holder document	Document that can have an ISSN.
issued on the occasion of	Relation denoting that a document has been/is issued on the occasion of a gathering.
Italian	Natural Language spoken by the natives of Italy.
J.P.E.G.	Data File Format of a visual document compressed in Joint Photographic Experts Group format.
J.P.E.G. format	Data File Format of a visual document compressed in Joint Photographic Experts Group format.
java programming	Progamming in JAVA object-oriented language.
joinery	231
joint photographic experts group format	Data File Format of a visual document compressed in Joint Photographic Experts Group format.
journal	Document corresponding to a serious magazine or newspaper which is published regularly, usually about a specialist subject.
JPEG	Data File Format of a visual document compressed in Joint Photographic Experts Group format.
keyword	Keyword representative of the content of the document.
knowledge acquisition	Field dealing with techniques for acquiring knowledge.
knowledge based systems	
knowledge dissemination	Diffusing knowledge previously acquired.
knowledge engineering	Field dealing with knowledge acquisition, representation, validation, inferencing, explanation and maintenance.
knowledge management	Field dealing with management techniques for knowledge capitalization in an organization.
knowledge modeling	Field dealing with modeling techniques for representing knowledge.
laboratory manager	Professional responsible for a laboratory.
language	Symbolic Representation System for communication consisting of a set of small parts and a set of rules which decide the ways in which these parts can be combined to produce messages that have meaning.
last name	The name used to identify the members of a family.
last visit	Date of the last visit to a document.
leaflet	Book (small) with a small number of pages often giving information about something.
lecture	Formal Gathering of persons with common interests, esp. professional interests, for the purpose of sharing information and opinions especially through lectures and debates.
lecture	Formal Gathering where a Person - lecturer - teaches by giving a discourse on some subject to a group of people students-.
legal	Activity concerned by the respect of the law.
legal corporation	Organization which is a private, legal, corporate entity with the legal rights to own property, able tomanage itself, and sue or be sued. It is established by a charter or registration granted by a government.
letter	Post Mail written or printed, usually put in an envelope and respecting a standard presentation.
lexicon	Dictionary usually small and limited to a particular language or subject.
lifeless entity	Physical Entity that cannot be alive.
lighting	15
lighting	243
liquid mechanics	
living being	Physical Entity that can be alive.
living entity	Physical Entity that can be alive.
local organisation	Organization Group of local scope, that is, members distributed in a local area - a Neighborhood, City, rural region, etc. - or having a local area of activity and concern.

local organization	Organization Group of local scope, that is, members distributed in a local area - a Neighborhood, City, rural region, etc. - or having a local area of activity and concern.
location	Spatial Entity which is a point or an extent in space.
logo	Document showing the emblem of a group.
low level language	Programming Language that is closer to the hardware than are High-level Languages, which are closer to human languages.
M.A.S.	Distributed Artificial Intelligence where the systems are designed as organizations of autonomous and loosely coupled pieces of software.
M.P.3	MPEG Format of a audio documents encoded according to the third coding schemes of MPEG.
M.P.E.G.	Data File Format of animated images/movie compressed in Moving Picture Experts Group format.
M.P.E.G. format	Data File Format of animated images/movie compressed in Moving Picture Experts Group format.
machine language	The lowest-level Programming Language that consistw entirely of numbers.
machine learning	Domain interested in methods enabling the computers to learn.
magazine	Document corresponding to a type of thin book with large pages which contains articles and photographs. It is usually intended to be a weekly or monthly paperback publication.
mail	Documents sent and delivered through a dedicated conveyance network.
mail	Mail sent in electronic format over a computerized world-wide communication system.
mail	Mail transmitted via the post office.
make something	Activity in which something - tangible - is made from some raw materials.
male	Person who belongs to the sex that cannot give birth.
manage	Relation denoting that an entity is in charge/controls of another entity.
manageable entity	Entity that can be managed.
management able entity	Entity that can manage another.
management board	Sub group of an organization formed by the heads of services.
management committee	Sub group of an organization formed by the President, the Director, the Director of Research and Development and the Technical Director.
manager	Professional whose primary job is to manage other people, directing their work activity. A Manager tells his or her subordinate workers what to do.
manual	Reference Document which gives you practical instructions on how to do something or how to use something, such as a machine.
manufacture	Make Something from raw materials or component parts that are combined to produce a product.
map	Document which, properly interpreted, models a region of physical space many times its own size by using graphical symbols - or possibly another code -, often in conjunction with a natural language.
marketing	Service by which a product or service is sold, including assessment of its sales potential and responsibility for its promotion and distribution.
markovian models	
MAS	Distributed Artificial Intelligence where the systems are designed as organizations of autonomous and loosely coupled pieces of software.
material and work technics	20
mathematical modelling	
mathematics	Topic concerned with the study of numbers, shapes and space using reason and usually a special system of symbols and rules for organizing them.
measurement	11
mechanical resistance	14
mechanics	Study of the effect of physical forces on objects and their movement.
medical care	Activity of medical care of patients, including surgery, psychological care, physical therapy, practical nursing, and dispensing drugs.
medical images processing	
medium	Value corresponding to a medium feedback given about a consultation
meeting	Gathering formally arranged for a particular purpose, usually in a dedicated room and/or around a table.
memo	Document corresponding to a message or other information in writing sent by one person or department to another in the same Organization.
metal	25
metrology	11
Microsoft Excel format	Data File Format of a visual document encoded in the format of Microsoft Excel workbook.
Microsoft Word format	Data File Format of a visual document encoded in the format of Microsoft Word.
minutes	Document containing of written record of what was said at a meeting.

mise a jour	Modification corresponding to content changed into more recent one.
mobile internet protocol	
mobile IP	
mobile number	Mobile phone number.
mobile phone architecture	
mobile phone frequency planning	
mobile phone planning system	
mobile phone protocols	
mobile phones	Telecommunications part concerned with portable radiotelephones.
mobile phone satelite service	
mobile phone service	
mobile phone technology	
mobile phone terminals	
modification	Corporate Memory Event corresponding to content transformed in the memory.
mortar	25
movie	Animation usually shown on a screen - cinema, TV, computer...- and often telling a story.
movie	Movie having spoken dialogue and/or soundtrack.
moving picture experts group format	Data File Format of animated images/movie compressed in Moving Picture Experts Group format.
MP3	MPEG Format of a audio documents encoded according to the third coding schemes of MPEG.
MP3 format	MPEG Format of a audio documents encoded according to the third coding schemes of MPEG.
MPEG	Data File Format of animated images/movie compressed in Moving Picture Experts Group format.
multi-agents systems	Distributed Artificial Intelligence where the systems are designed as organizations of autonomous and loosely coupled pieces of software.
multinational	Organization Group of international scope, that is, one which has substantial operations, physical facilities, or substantial membership in multiple countries.
music	
musical language	Natural Language representing musical notes.
name	The name used to identify the members of a family.
narration	Document corresponding to an account describing incidents or events.
national organisation group	Organization Group of nationwide scope, that is distribution throughout some Country of its members and/or activities.
national organization	Organization Group of nationwide scope, that is distribution throughout some Country of its members and/or activities.
natural language	Language used by human beings, which has evolved naturally.
network	A group of two or more computer systems linked together.
network type	ex: mobile, fixed, satellite
newcomer	Person newly arrived in the company.
news	Document about recent events.
newsgroup message	Document corresponding to messages displayed on the Internet and devoted to the discussion of a specified topic.
news letter	News issued to members of an Organization.
newspaper	Document regularly printed and consisting of news reports, articles, photographs and advertisements, and that is usually intended to be printed on a daily or weekly basis on large sheets of paper which are folded together but not permanently joined.
nomenclature	Reference Document which gives a system for naming things, especially in a particular area of science.
non ferrous metal	25
non-linear filtering	
non-linear systems	
non spatial entity	Entity that has no spatial nature and does not pertain to space.
number	(Period) number of a serial document.
numberable entity	Entity to which one or more numbers are associated.
numerical analysis	
numeric format	Storage format based on discontinuous data.
object-programming	A type of programming in which programmers define not only the data type of a data structure, but also the types of operations -functions- that can be applied to the data structure.
observer	Technical monitoring actor required to monitor and filter all the technical and strategic documentation on innovative services they came across and send anything they judge as interesting input for the technology monitoring process to his area referent.

official document	Document agreed to or arranged by people in positions of authority.
ontology engineering	Field dealing with the engineering of explicit, partial specification of a conceptualization.
order form	Form which a customer uses to request goods or a service.
organisation	Organization Group including both informal and legally constituted organizations.
organisational entity	Entity recognized by and within the organization.
organisation group	An arganizational entity is composed of other Organization Entity working together in a structured way for a shared purpose.
organization	Organization Group including both informal and legally constituted organizations.
organizational entity	Entity recognized by and within the organization.
organization chart	Diagram that graphically or in outline fashion depicts information about the control structure or resource use structure of an organization.
organization group	An arganizational entity is composed of other Organization Entity working together in a structured way for a shared purpose.
organization homepage	Homepage of an Organization s Web Site.
organization part	Organization Group which is a sub-organization of another Organization Group.
organization policy	Manual that contains the terms of some policy of a particular organization.
organized by	Relation denoting that an entity organizes / organized a gathering.
outer covering	235
outer layer	222
outside development	21
oversee	Relation denoting that an entity is in charge/controls of another entity.
P.D.A.	
P.D.F.	Data File Format of a visual document encoded in Adobe Portable Document Format.
P.D.F. format	Data File Format of a visual document encoded in Adobe Portable Document Format.
P.S.	Data File Format of a visual document encoded in Postscript format.
P.S. format	Data File Format of a visual document encoded in Postscript format.
pamphlet	Book (small) with a small number of pages often giving information about something.
paper	25
paper	Documentary Medium which is a thin flat material, made from crushed wood or cloth and used for writing, printing or drawing on.
parallel- object- programming	
parallel programming	A type of programming where processes occur simultaneously.
partition	234
partner	Organization with which an Organization is associated and collaborates. The cooperation can be limited (e.g. for the realization of a contract for a customer) or durable (mutual recognition of the evaluation procedures and test results, institutional partnership).
part time	Contract type of an employee working part-time for an organization.
party event	Social Gathering at one location for people to communicate share some experience and to enjoy themselves.
patent	Official document that confers upon the creator of an invention the sole right to make, use, and sell that invention for a given period of time.
pathology	26
pattern	Pattern of annotation or query.
payroll	Finance activity concerned with maintaining the list of the people employed, showing the total amount of money paid to the people employed by a particular company.
PDA	
PDF	Data File Format of a visual document encoded in Adobe Portable Document Format.
perception mode	Document Attribute giving the perception channel/way.
period number	(Period) number of a serial document.
person	Living Entity belonging to mankind, an individual human being.
personal digital assistant	
personal homepage	Homepage of a Person s Web Site
Ph.D. student	Student carrying supervised research usually based on at least 3 years graduate study and a dissertation to obtain a Ph.D./doctorate (the highest degree awarded by a graduate school).
phone number	Phone number of a location.
physical entity	Spatial Entity made of matter.
physics	Science of matter and energy and their interactions.

picture	Graphic visually representing an object, a scene, a person... and produced on a surface.
pipe and shaft	235
plaster	25
pole	Functional subdivision of a service. It has generally 2 to 8 people.
polymer	25
Portable Document Format	Data File Format of a visual document encoded in Adobe Portable Document Format.
postcard	Post Mail consisting in a small, rectangular card, usually with a picture on one side and a message on the other, that can be sent without an envelope.
Post-doctorate	Student who recently finished his Ph.D. and has a contract with a limited duration to continue his search.
post mail	Mail transmitted via the post office.
postscript	Data File Format of a visual document encoded in Postscript format.
Post Script Format	Data File Format of a visual document encoded in Postscript format.
presentation	Document presenting news or other information and intended to be broadcasted or printed.
private gathering	Gathering restricted to one particular group, not to other people.
probabilistics	
probabilities	
proceedings	Document containing a written account of what transpired at a event and the documents presented by the actors of the event.
professional	Person who does activities that are characteristic of some job/profession/occupation for a livelihood.
profile	Document containing a biographical sketch.
programing language	Artificial Language for instructing a computer to perform specific tasks.
programming	Science of organizing instructions so that, when executed, they cause the computer to behave in a predetermined manner.
programming language	Artificial Language for instructing a computer to perform specific tasks.
project	Temporary group of individual working on a planned activity for a client with an associated fixed budget.
project group	Temporary group of individual working on a planned activity for a client with an associated fixed budget.
promotion	Document of a public announcement, especially to proclaim the qualities or advantages of some product or service so as to increase sales.
PS	Data File Format of a visual document encoded in Postscript format.
public document	The diffusion is not subjected to any restriction.
public gathering	Gathering allowing anyone to see or hear what is happening.
publicity	Document of a public announcement, especially to proclaim the qualities or advantages of some product or service so as to increase sales.
purchase	Commerce activity where a person or an organization obtains something by paying money for it.
pushed document	Document pushed by the CoMMA Push Mode.
pushed document trace	Such an element is created when the CoMMA push mode process retreive a document that can interests user.
quality assessment	Evaluation and certification of products and process.
R.D.F.	Web Resource Description Framework.
R.M.I.	Remote Method Invocation, a set of protocols being developed by Sun s JavaSoft division that enables Java objects to communicate remotely with other Java objects.
rating given	User s feedback after a consultation. Can be like Good, Bad, etc. cf RatingValue.
rating value	Type of the feedback given after consulting a resource.
RDF	Web Resource Description Framework.
RDF string	String representing the RDF pattern.
record tape	Documentary Medium where the recording is done on a magnetic tape.
reference document	Document to which you can refer for authoritative facts.
refers monitoring to	Links an observer to the referent of his area.
regional organisation	Organization Group of local scope, that is, members distributed in a local area - a Neighborhood, City, rural region, etc. - or having a local area of activity and concern.
regional organization	Organization Group of local scope, that is, members distributed in a local area - a Neighborhood, City, rural region, etc. - or having a local area of activity and concern.
related to	Relation denoting that an Interest Field is linked to another.
reliability	Reliability of the information.
remote method invocation	Remote Method Invocation, a set of protocols being developed by Sun s JavaSoft division that enables Java objects to communicate remotely with other Java

	objects.
report	Document, usually a concise one, on a well defined topic and taking into account the identity of the readers.
representation system	Document Attribute describing the system - signs, symbols, indices... - that serves as a means of expressing a Document Element in order to exhibit it to the mind.
research	Service providing detailed study of a subject, esp. in order to discover -new- information or reach a -new- understanding.
research direction	Organization Part responsible for a specific technical field e.g. mobile field.
researcher	Professional working in the Activity Field of Research, carrying out detailed study of a subject, esp. in order to discover - new - information or reach a - new - understanding.
research report	Report presenting studies.
resource description framework	Web Resource Description Framework.
restoration	Service of preparing and/or serving food.
RMI	Remote Method Invocation, a set of protocols being developed by Sun s JavaSoft division that enables Java objects to communicate remotely with other Java objects.
road	21
robotics	branch of Artificial Intelligence concerned with the practical use of robots.
role entity	Entity that can play a role in a relation.
roof	223
rubber	25
sale	Commerce activity where a person or an organization gives a product or a service to another in return for money.
sales assistant	Professional employed to sell merchandise to customers in a store or to customers that are visited.
sales clerk	Professional employed to sell merchandise to customers in a store or to customers that are visited.
sales man	Professional employed to sell merchandise to customers in a store or to customers that are visited.
sanitary equipment	242
scenario analysis	Document based on available information about technologies, proposing potential medium term strategic scenarios. Reasonably there will be only a few reports of this kind in a year.
sciences applied to building	10
scientist	Professional educated and employed in one - or more - of the natural or abstract sciences.
sculpture	Iconic Representation System producing three-dimensional and usually tangible representations.
second work	23
secretary	Assistant who handles correspondence and clerical work for a boss or an organization.
security	65
see also	Other source of the information.
self employed	Contract type of an professional who earns a living from funds paid directly to him/her by customers, or who is paid by a company s/he owns. An Self-employed has no boss but him/herself.
sell	Commerce activity where a person or an organization gives a product or a service to another in return for money.
service	Activity where a work is done by one person or group that benefits another.
service	Basic functional unit. A service is part of a department and is made up of several divisions or poles.
service group	Basic functional unit. A service is part of a department and is made up of several divisions or poles.
service provider	indicates the provider of telecommunication services or technologies or terminals.
service type	
sexual attribute	Attribute representing either of the two categories - male or female - into which most organisms are divided.
shell	22
shop assistant	Professional employed to sell merchandise to customers in a store or to customers that are visited.
shutter	231
sign language	Natural Language expressed by visible hand gestures.
silent movie	Movie having no spoken dialogue and usually no soundtrack.
simulation	Science of theoretical account based on a similarity between the model and the

	phenomena that are to be explained.
single site organization	Organization Group which has a single location as its physical quarters.
situable entity	Entity that can have a known location.
situated	Relation denoting that an Entity is located in a Location.
sleeping partner	Relation designating a sleeping partner of the report.
slide	Document of one page usually concise and prepared to be presented to a public by projection.
social gathering	Formal Gathering of people who have the same or similar purposes in attending, and in which there is communication between the participants with sociability and maybe communal activities.
social ritual	Social Gathering in which some kind of ritual is performed. E.g., a wedding, an awards ceremony, a baptism, an inauguration, a graduation ceremony, etc.
social science	30
software engineering	The computer science discipline concerned with developing computer applications.
soil mechanics	17
some relation	An abstraction belonging to, linking, or characterising of two things.
something	Whatever exists animate, inanimate or abstraction.
sound insulation	232
sound proofing	232
source	Source of the information.
Spanish	Natural Language spoken by the natives of Spain.
spatial entity	Entity pertaining to or having the nature of space.
speech	Document corresponding to a formal talk given usually to a large number of people on a special occasion.
sports event	Entertainment Event based on sport activities.
spreadsheet	Document with multiple columns and rows to organize data for calculating and making adjustments based on new data.
spread sheet	Document with multiple columns and rows to organize data for calculating and making adjustments based on new data.
stability	14
static image	Image not changing for a long time.
statistics	Branch of applied mathematics concerned with the collection and interpretation of quantitative data and the use of probability theory to estimate population parameters.
stochastic dynamic systems	
stone	25
storage format	A particular arrangement to hold and retain data.
story	Document corresponding to an account describing incidents or events.
structure	221
student	Person who studies at an academic institution. This collection includes students at all levels of study in all types of educational institutions.
subsidiary	Organization that is completely controlled by another.
summary	A account of the main points of a document.
superintend	Relation denoting that an entity is in charge/controls of another entity.
supervise	Relation denoting that an entity is in charge/controls of another entity.
supervised by	Organization (school, university, laboratory...) supervising the thesis.
supervision authority	Organization having the legal authority to supervise the activities of other organizations (ex. housing ministry).
surname	The name used to identify the members of a family.
symbolic learning	Domain interested in methods enabling the computers to learn.
symbolic representation system	Representation System based on symbols that are associated with the objects they represent by a rule - e.g. the word "bird" and a real bird.
tactile	Documentary Perception Mode perceptible by touch.
talk	Formal Gathering where a Person - lecturer - teaches by giving a discourse on some subject to a group of people students-.
talking movie	Movie having spoken dialogue and/or soundtrack.
target	Relation denoting that a Document is intended for some Entity.
TCP/IP	Transmission Control Protocol/Internet Protocol, the suite of communications protocols used to connect hosts on the Internet.
TCP-IP	Transmission Control Protocol/Internet Protocol, the suite of communications protocols used to connect hosts on the Internet.
teach	Activity in which some people impart learned knowledge to others.
teaching	Activity in which some people impart learned knowledge to others.
technical report	Report presenting technical results.
technician	Professional trained in some specific technical processes.
technology	

technology monitoring actor	A Person playing a role in technology monitoring process.
telecommunications	Domain concerned with the technology of electronic communication at a distance.
temporary	Contract type of an employee working temporary for an organization.
terracotta	25
test	11
test laboratory	Group in charge of tests and attached to a service or a division.
text format	Data file format storing data in ASCII.
thermal insulation	232
thermics	15
thesis	Document corresponding to a long piece of writing on a particular subject advancing a new point of view resulting from research ; it is usually a requirement for an advanced academic degree.
thesis research domain	Domain associated given by the national nomenclature.
thesis research type	Type associated given by the national nomenclature.
thing	Whatever exists animate, inanimate or abstraction.
thing	Thing which exists apart from other Things, having its own independent existence and that can be involved in Events.
time	Time Entity corresponding to a time of day.
time entity	Entity related to the continuum of experience in which events pass from the future through the present to the past.
time point	Time Entity corresponding to a particular, instantaneous point in time.
title	Designation of a document.
tongue	Symbolic Representation System for communication consisting of a set of small parts and a set of rules which decide the ways in which these parts can be combined to produce messages that have meaning.
topology	Branch of pure mathematics that deals only with the properties of a figure X that hold for every figure into which X can be transformed with a one-to-one correspondence.
trainee	Student who is being trained during an internship the organization.
training document	Training document containing pedagogical material and usually used by lecturers or teachers as a support of their lessons.
training period	Contract type of an employee who is learning and practicing the skills of a particular job.
training period report	Report written by a trainee at the end of its training period. Rarely confidential, these reports deal with very restricted area.
trainnee originating from	Organization (school, university, laboratory...) from where the trainee was originating.
transparency	Document of one page usually concise and prepared to be presented to a public by projection.
transparency show	Document corresponding to an ordered set of transparencies usually grouped around a topic.
transport	Service of providing transportation of goods or persons.
travel	Service giving information about prices and schedules for a trip and arranging tickets and accommodation.
trend analysis	Synthesis Document written by an expert on the trends of a technological area.
tutor	A person who gives private advice and instruction to a newcomer.
type	Type associated given by the national nomenclature.
U.M.L.	General-purpose notational Artificial Language for specifying and visualizing complex software, especially large, object-oriented projects.
U.M.T.S.	
UML	General-purpose notational Artificial Language for specifying and visualizing complex software, especially large, object-oriented projects.
UMTS	
unified modeling language	General-purpose notational Artificial Language for specifying and visualizing complex software, especially large, object-oriented projects.
union	Group of individuals formed to bargain with the employer.
unit	Group of individuals corresponding to a group of researchers focusing on a sub interest field e.g.: microwaves.
universal mobile telecommunications system	
university	Organization which does university-level teaching and/or research.
update	Modification corresponding to content changed into more recent one.
ventilation shaft	235
virtual reality	Iconic Representation System for simulating systems or environments with and within which people can interact.
virtual reality	A computer simulation of a real or imaginary system that enables a user to

	perform operations on the simulated system and shows the effects in real time.
visit count	Number of visits to a document in the whole history of a profile.
visited document	Document concerned by this element of the use history of a profile.
visitor	Person concerned by this element of the history of a profile.
visual	Documentary Perception Mode by sight.
visual perception	
W.A.P	Wireless Application Protocol is a secure specification that allows users to access information instantly via handheld wireless devices such as mobile phones, pagers, two-way radios, smartphones and communicators.
W.M.L.	Wireless Markup Language is an XML language used to specify content and user interface for WAP devices.
wall coating	233
wap	Wireless Application Protocol is a secure specification that allows users to access information instantly via handheld wireless devices such as mobile phones, pagers, two-way radios, smartphones and communicators.
WAP	Wireless Application Protocol is a secure specification that allows users to access information instantly via handheld wireless devices such as mobile phones, pagers, two-way radios, smartphones and communicators.
water analyze and treatment	16
wav	Data File Format of a audio document encoded in the WAV format.
wave propagation	
WAV Format	Data File Format of a audio document encoded in the WAV format.
Web	Internet servers networks that support specially formatted documents.
web page	Document corresponding to a page on the World Wide Web.
web site	Document corresponding to a page on the World Wide Web.
web site	Document made up of interconnected Web Pages, usually including a Homepage, generally located on the same server, and prepared and maintained as a collection of information by a person, group, or organization.
welcome page	Web Page designed to be the main page of a Web site. Typically, the home page serves as an index or table of contents to other documents stored at the site.
window	231
wireless application protocol	Wireless Application Protocol is a secure specification that allows users to access information instantly via handheld wireless devices such as mobile phones, pagers, two-way radios, smartphones and communicators.
wireless markup language	Wireless Markup Language is an XML language used to specify content and user interface for WAP devices.
wml	Wireless Markup Language is an XML language used to specify content and user interface for WAP devices.
Word	Data File Format of a visual document encoded in the format of Microsoft Word.
Word format	Data File Format of a visual document encoded in the format of Microsoft Word.
worker	Professional member of the working class with a specific job.
X.M.L.	Text Format of a Documentary Element written in eXtensible Markup Language.
X.M.L.	Web Extensible Markup Language enabling the definition, transmission, validation, and interpretation of data between applications and between organizations.
X.M.L. Format	Text Format of a Documentary Element written in eXtensible Markup Language.
XML	Text Format of a Documentary Element written in eXtensible Markup Language.
XML	Web Extensible Markup Language enabling the definition, transmission, validation, and interpretation of data between applications and between organizations.
zip	Data File Format for files compressed in ZIP format.
zip format	Data File Format for files compressed in ZIP format.

Appendix B. RDFS ONTOLOGY FILE

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<rdf:RDF xmlns:rdfs="http://www.w3.org/TR/1999/PR-rdf-
schema-19990303#" xmlns:rdf="http://www.w3.org/1999/02/22-
rdf-syntax-ns#" xmlns="http://www.w3.org/TR/REC-html40"
xmlns:cos="http://www.inria.fr/acacia/corese#">

<!-- Ontology version 4.4 -->

<!-- Top -->

<rdfs:Class rdf:ID="Something">
<rdfs:comment xml:lang="en">Whatever exists animate,
inanimate or abstraction.</rdfs:comment>
<rdfs:comment xml:lang="fr">Tout ce qui existe anime,
inanime ou abstraction.</rdfs:comment>
<rdfs:label xml:lang="en">thing</rdfs:label>
<rdfs:label xml:lang="en">something</rdfs:label>
<rdfs:label xml:lang="en">anything</rdfs:label>
<rdfs:label xml:lang="fr">chose</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Entity">
<rdfs:subClassOf rdf:resource="#Something"/>
<rdfs:comment xml:lang="en">Thing which exists apart from
other Things, having its own independent existence and
that can be involved in Events.</rdfs:comment>
<rdfs:comment xml:lang="fr">chose qui existe
independamment d autres choses, ayant sa propre existence
independante et qui peut etre impliquee dans les
evenements.</rdfs:comment>
<rdfs:label xml:lang="en">entity</rdfs:label>
<rdfs:label xml:lang="en">thing</rdfs:label>
<rdfs:label xml:lang="fr">entite</rdfs:label>
<rdfs:label xml:lang="fr">chose</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SpatialEntity">
<rdfs:subClassOf rdf:resource="#Entity"/>
<rdfs:comment xml:lang="en">Entity pertaining to or having
the nature of space.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite appartenant ou ayant la
nature de l espace.</rdfs:comment>
<rdfs:label xml:lang="en">spatial entity</rdfs:label>
<rdfs:label xml:lang="fr">entite spatiale</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PhysicalEntity">
<rdfs:subClassOf rdf:resource="#SpatialEntity"/>
<rdfs:comment xml:lang="en">Spatial Entity made of
matter.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite spatiale faite de
matiere.</rdfs:comment>
<rdfs:label xml:lang="en">physical entity</rdfs:label>
<rdfs:label xml:lang="fr">entite physique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="LivingEntity">
<rdfs:subClassOf rdf:resource="#PhysicalEntity"/>
<rdfs:comment xml:lang="en">Physical Entity that can be
alive.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite Physique qui peut etre
vivante.</rdfs:comment>
<rdfs:label xml:lang="en">living being</rdfs:label>
<rdfs:label xml:lang="en">living entity</rdfs:label>
<rdfs:label xml:lang="fr">etre vivant</rdfs:label>
<rdfs:label xml:lang="fr">entite vivante</rdfs:label>
</rdfs:Class>


<rdfs:Class rdf:ID="LifelessEntity">
<rdfs:subClassOf rdf:resource="#PhysicalEntity"/>
<rdfs:comment xml:lang="en">Physical Entity that cannot be
alive.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite Physique qui ne peut
pas être vivante.</rdfs:comment>
<rdfs:label xml:lang="en">inert entity</rdfs:label>
<rdfs:label xml:lang="en">lifeless entity</rdfs:label>
<rdfs:label xml:lang="fr">entite inerte</rdfs:label>
<rdfs:label xml:lang="fr">entite sans vie</rdfs:label>
</rdfs:Class>


<rdfs:Class rdf:ID="NonSpatialEntity">
<rdfs:subClassOf rdf:resource="#Entity"/>
<rdfs:comment xml:lang="en">Entity that has no spatial
nature and does not pertain to space.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite qui n a aucune nature
spatiale et n appartient pas a l espace.</rdfs:comment>
<rdfs:label xml:lang="en">non spatial entity</rdfs:label>
<rdfs:label xml:lang="fr">entite non spatiale</rdfs:label>
</rdfs:Class>

<!-- Attributes Values -->

<rdfs:Class rdf:ID="Attribute">
<rdfs:subClassOf rdf:resource="#NonSpatialEntity"/>
<rdfs:comment xml:lang="en">Predefined entities
characterizing other entities.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entites predefinies
caracterisant d autres entites.</rdfs:comment>
<rdfs:label xml:lang="en">attribute</rdfs:label>
<rdfs:label xml:lang="fr">attribut</rdfs:label>
</rdfs:Class>


<!-- Person attributes -->

<rdfs:Class rdf:ID="SexualAttribute">
<rdfs:subClassOf rdf:resource="#Attribute"/>
<rdfs:comment xml:lang="en">Attribute representing either
of the two categories - male or female - into which most
organisms are divided.</rdfs:comment>
<rdfs:comment xml:lang="fr">Attribut representant les deux
categories - mele ou femelle - selon lesquelles la plupart
des etres vivants sont divises.</rdfs:comment>
<rdfs:label xml:lang="en">sexual attribute</rdfs:label>
<rdfs:label xml:lang="fr">attribut sexuel</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Female">
<rdfs:subClassOf rdf:resource="#SexualAttribute"/>
<rdfs:comment xml:lang="en">Person of the sex that can
give birth.</rdfs:comment>
<rdfs:comment xml:lang="fr">Personne du sexe qui peut
donner naissance.</rdfs:comment>
<rdfs:label xml:lang="en">female</rdfs:label>
<rdfs:label xml:lang="fr">feminin</rdfs:label>
<rdfs:label xml:lang="fr">femelle</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Male">
<rdfs:subClassOf rdf:resource="#SexualAttribute"/>
<rdfs:comment xml:lang="en">Person who belongs to the sex
that cannot give birth.</rdfs:comment>
<rdfs:comment xml:lang="fr">Personne qui appartient au
sexe qui ne peut pas donner naissance.</rdfs:comment>
<rdfs:label xml:lang="en">male</rdfs:label>
<rdfs:label xml:lang="fr">masculin</rdfs:label>
<rdfs:label xml:lang="fr">male</rdfs:label>
</rdfs:Class>

<!-- Employee attributes -->

<rdfs:Class rdf:ID="ContractTypeAttribute">
<rdfs:subClassOf rdf:resource="#Attribute"/>
<rdfs:comment xml:lang="en">Type of
contract.</rdfs:comment>
<rdfs:comment xml:lang="fr">Type de
contrat.</rdfs:comment>
<rdfs:label xml:lang="en">contract type
attribute</rdfs:label>
<rdfs:label xml:lang="fr">attribut type de
contract</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="FullTime">
<rdfs:subClassOf rdf:resource="#ContractTypeAttribute"/>
<rdfs:comment xml:lang="en">Contract type of an employee
working full-time for an organization.</rdfs:comment>
<rdfs:comment xml:lang="fr">Type de contrat d un employe
travaillant a plein temps pour une
organisation.</rdfs:comment>
<rdfs:label xml:lang="en">full time</rdfs:label>
<rdfs:label xml:lang="fr">a plein temps</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PartTime">
<rdfs:subClassOf rdf:resource="#ContractTypeAttribute"/>
<rdfs:comment xml:lang="en">Contract type of an employee
working part-time for an organization.</rdfs:comment>
<rdfs:comment xml:lang="fr">Type de contrat d un employe
travaillant a temps partiel pour une
organisation.</rdfs:comment>
<rdfs:label xml:lang="en">part time</rdfs:label>
<rdfs:label xml:lang="fr">a temps partiel</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Temporary">
<rdfs:subClassOf rdf:resource="#ContractTypeAttribute"/>
<rdfs:comment xml:lang="en">Contract type of an employee
working temporary for an organization.</rdfs:comment>
<rdfs:comment xml:lang="fr">Type de contrat d un employe
travaillant provisoirement pour une
organisation.</rdfs:comment>
<rdfs:label xml:lang="en">temporary</rdfs:label>
<rdfs:label xml:lang="fr">temporaire</rdfs:label>
</rdfs:Class>
```

```
<rdfs:Class rdf:ID="SelfEmployed">
<rdfs:subClassOf rdf:resource="#ContractTypeAttribute"/>
<rdfs:comment xml:lang="en">Contract type of an
professional who earns a living from funds paid directly
to him/her by customers, or who is paid by a company s/he
owns. An Self-employed has no boss but
him/herself.</rdfs:comment>
<rdfs:comment xml:lang="fr">Type de contrat d un
professionnel qui gagne sa vie des fonds payes directement
a par ses clients, ou qui est paye par une compagnie qu il
possede. Un independant n a aucun patron.</rdfs:comment>
<rdfs:label xml:lang="en">self employed</rdfs:label>
<rdfs:label xml:lang="fr">independant</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="IndependentContractor">
<rdfs:subClassOf rdf:resource="#SelfEmployed"/>
<rdfs:comment xml:lang="en">Contract type of a self-
employed professional who is retained to perform a certain
act but who is subject to the control and direction of
another only as to the end result and not as to the way in
which the act is performed.</rdfs:comment>
<rdfs:comment xml:lang="fr">Type de contrat d un
professionnel independant qui est tenu d executer
certaines taches mais qui n est sujet au controle et a la
direction que sur ses resultats finaux et pas sur sa
methode de travail.</rdfs:comment>
<rdfs:label xml:lang="en">independent
contractor</rdfs:label>
<rdfs:label xml:lang="fr">entrepreneur
independant</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="TrainingPeriod">
<rdfs:subClassOf rdf:resource="#ContractTypeAttribute"/>
<rdfs:comment xml:lang="en">Contract type of an employee
who is learning and practicing the skills of a particular
job.</rdfs:comment>
<rdfs:comment xml:lang="fr">Type de contrat d un employe
qui s entraine et apprend les qualifications d un travail
particulier</rdfs:comment>
<rdfs:label xml:lang="en">training period</rdfs:label>
<rdfs:label xml:lang="fr">stage</rdfs:label>
</rdfs:Class>


<!-- Document attributes -->

<rdfs:Class rdf:ID="DocumentAttribute">
<rdfs:subClassOf rdf:resource="#Attribute"/>
<rdfs:comment xml:lang="en">Attribut characteristic of
documents.</rdfs:comment>
<rdfs:comment xml:lang="fr">Attribut caracteristique des
documents.</rdfs:comment>
<rdfs:label xml:lang="en">document attribute</rdfs:label>
<rdfs:label xml:lang="fr">attribut de
document</rdfs:label>
</rdfs:Class>


<!-- Perception attributes -->

<rdfs:Class rdf:ID="DocumentaryPerceptionMode">
<rdfs:subClassOf rdf:resource="#DocumentAttribute"/>
<rdfs:comment xml:lang="en">Document Attribute giving the
perception channel/way.</rdfs:comment>
<rdfs:comment xml:lang="fr">Attribut de document qui donne
le moyen de perception.</rdfs:comment>
<rdfs:label xml:lang="en">perception mode</rdfs:label>
<rdfs:label xml:lang="fr">mode de perception</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="VisualPerceptionMode">
<rdfs:subClassOf
rdf:resource="#DocumentaryPerceptionMode"/>
<rdfs:comment xml:lang="en">Documentary Perception Mode by
sight.</rdfs:comment>
<rdfs:comment xml:lang="fr">Mode de Perception par la
vue.</rdfs:comment>
<rdfs:label xml:lang="en">visual</rdfs:label>
<rdfs:label xml:lang="fr">visuel</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="AudioPerceptionMode">
<rdfs:subClassOf
rdf:resource="#DocumentaryPerceptionMode"/>
<rdfs:comment xml:lang="en">Documentary Perception Mode by
hearing.</rdfs:comment>
<rdfs:comment xml:lang="fr">Mode de Perception par l
audition.</rdfs:comment>
<rdfs:label xml:lang="en">auditory</rdfs:label>
<rdfs:label xml:lang="fr">auditif</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="TactilePerceptionMode">
<rdfs:subClassOf
rdf:resource="#DocumentaryPerceptionMode"/>
<rdfs:comment xml:lang="en">Documentary Perception Mode
perceptible by touch.</rdfs:comment>
<rdfs:comment xml:lang="fr">Mode de Perception par le
toucher</rdfs:comment>
<rdfs:label xml:lang="en">tactile</rdfs:label>
<rdfs:label xml:lang="fr">tactile</rdfs:label>
</rdfs:Class>


<!-- Representation attributes -->

<rdfs:Class rdf:ID="DocumentaryRepresentationSystem">
<rdfs:subClassOf rdf:resource="#DocumentAttribute"/>
<rdfs:comment xml:lang="en">Document Attribute describing
the system - signs, symbols, indices... - that serves as a
means of expressing a Document Element in order to exhibit
it to the mind.</rdfs:comment>
<rdfs:comment xml:lang="fr">Attribut décrivant le systeme
- signes, symboles, indices... -  utilise pour exprimer un
document afin de le montrer a l esprit.</rdfs:comment>
<rdfs:label xml:lang="en">representation
system</rdfs:label>
<rdfs:label xml:lang="fr">systeme de
representation</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="IconicRepresentationSystem">
<rdfs:subClassOf
rdf:resource="#DocumentaryRepresentationSystem"/>
<rdfs:comment xml:lang="en">Documentary Representation
System  based on icons that perceptually resemble the
objects they represent - e.g. the drawing of an apple and
a real apple -</rdfs:comment>
<rdfs:comment xml:lang="fr">Le systeme de representation
base sur le graphisme et dont la perception ressemble aux
objets representes - par exemple le dessin d une pomme et
une vraie pomme -.</rdfs:comment>
<rdfs:label xml:lang="en">iconic representation
system</rdfs:label>
<rdfs:label xml:lang="fr">systeme de representation
iconique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SculptureRepresentation">
<rdfs:subClassOf
rdf:resource="#IconicRepresentationSystem"/>
<rdfs:comment xml:lang="en">Iconic Representation System
producing three-dimensional and usually tangible
representations.</rdfs:comment>
<rdfs:comment xml:lang="fr">Representation iconique
tridimensionnelle et habituellement
tangible.</rdfs:comment>
<rdfs:label xml:lang="en">sculpture</rdfs:label>
<rdfs:label xml:lang="en">carving</rdfs:label>
<rdfs:label xml:lang="fr">sculpture</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="VirtualReality">
<rdfs:subClassOf
rdf:resource="#IconicRepresentationSystem"/>
<rdfs:comment xml:lang="en">Iconic Representation System
for simulating systems or environments with and within
which people can interact.</rdfs:comment>
<rdfs:comment xml:lang="fr">Systeme de representation
iconique pour simuler des systemes ou des environnements a
l interieur desquelles et avec lesquelles les personnes
peuvent interagir.</rdfs:comment>
<rdfs:label xml:lang="en">virtual reality</rdfs:label>
<rdfs:label xml:lang="fr">realite virtuelle</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="GraphicRepresentation">
<rdfs:subClassOf
rdf:resource="#IconicRepresentationSystem"/>
<rdfs:comment xml:lang="en">Iconic Representation written
or drawn, printed or engraved.</rdfs:comment>
<rdfs:comment xml:lang="fr">Representation iconique ecrite
ou dessinee, imprimee ou gravee.</rdfs:comment>
<rdfs:label xml:lang="en">graphic</rdfs:label>
<rdfs:label xml:lang="fr">graphique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ImageRepresentation">
<rdfs:subClassOf rdf:resource="#GraphicRepresentation"/>
<rdfs:comment xml:lang="en">Graphic visually representing
an object, a scene, a person... and produced on a
surface.</rdfs:comment>
<rdfs:comment xml:lang="fr">Graphique representant
visuellement un objet, une scene, une personne... et
produit sur une surface.</rdfs:comment>
<rdfs:label xml:lang="en">image</rdfs:label>
<rdfs:label xml:lang="en">picture</rdfs:label>
<rdfs:label xml:lang="fr">image</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="DynamicImageRepresentation">
<rdfs:subClassOf rdf:resource="#ImageRepresentation"/>
<rdfs:comment xml:lang="en">Image changing over time
quickly enough to be noticed.</rdfs:comment>
<rdfs:comment xml:lang="fr">Image changeant avec le temps
assez rapidement pour que cela soit
visible.</rdfs:comment>
<rdfs:label xml:lang="en">dynamic image</rdfs:label>
<rdfs:label xml:lang="fr">image dynamique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="AnimationRepresentation">
<rdfs:subClassOf
rdf:resource="#DynamicImageRepresentation"/>
```

```
<rdfs:comment xml:lang="en">Dynamic Image that appears to
move.</rdfs:comment>
<rdfs:comment xml:lang="fr">Image dynamique qui semble
bouger.</rdfs:comment>
<rdfs:label xml:lang="en">animation</rdfs:label>
<rdfs:label xml:lang="fr">animation</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MovieRepresentation">
<rdfs:subClassOf rdf:resource="#AnimationRepresentation"/>
<rdfs:comment xml:lang="en">Animation usually shown on a
screen - cinema, TV, computer...- and often telling a
story.</rdfs:comment>
<rdfs:comment xml:lang="fr">animation habituellement
montree sur un ecran - cinema, TV, ordinateur...- et
contant souvent une histoire. </rdfs:comment>
<rdfs:label xml:lang="en">movie</rdfs:label>
<rdfs:label xml:lang="en">film</rdfs:label>
<rdfs:label xml:lang="fr">film</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SilentMovieRepresentation">
<rdfs:subClassOf rdf:resource="#MovieRepresentation"/>
<rdfs:comment xml:lang="en">Movie having no spoken
dialogue and usually no soundtrack.</rdfs:comment>
<rdfs:comment xml:lang="fr">Film n ayant aucun dialogue
parle et habituellement aucune bande son.</rdfs:comment>
<rdfs:label xml:lang="en">silent movie</rdfs:label>
<rdfs:label xml:lang="fr">film muet</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="TalkingMovieRepresentation">
<rdfs:subClassOf rdf:resource="#MovieRepresentation"/>
<rdfs:comment xml:lang="en">Movie having spoken dialogue
and/or soundtrack.</rdfs:comment>
<rdfs:comment xml:lang="fr">Film ayant des dialogues
parles et/ou une bande son.</rdfs:comment>
<rdfs:label xml:lang="en">movie</rdfs:label>
<rdfs:label xml:lang="en">talking movie</rdfs:label>
<rdfs:label xml:lang="fr">film</rdfs:label>
<rdfs:label xml:lang="fr">film avec bande son</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="StaticImage">
<rdfs:subClassOf rdf:resource="#ImageRepresentation"/>
<rdfs:comment xml:lang="en">Image not changing for a long
time.</rdfs:comment>
<rdfs:comment xml:lang="fr">Image ne changeant pas pendant
visiblement.</rdfs:comment>
<rdfs:label xml:lang="en">static image</rdfs:label>
<rdfs:label xml:lang="fr">image statique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SymbolicRepresentationSystem">
<rdfs:subClassOf
rdf:resource="#DocumentaryRepresentationSystem"/>
<rdfs:comment xml:lang="en">Representation System  based
on symbols that are associated with the objects they
represent by a rule - e.g. the word "bird" and a real
bird.</rdfs:comment>
<rdfs:comment xml:lang="fr">Systeme de representation base
sur les symboles qui sont associes par une regle aux
objets qu ils representent - par exemple le mot o-i-s-e-a-
u et un vrai oiseau.</rdfs:comment>
<rdfs:label xml:lang="en">symbolic representation
system</rdfs:label>
<rdfs:label xml:lang="fr">systeme de representation
symbolique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Language">
<rdfs:subClassOf
rdf:resource="#SymbolicRepresentationSystem"/>
<rdfs:comment xml:lang="en">Symbolic Representation System
for communication consisting of a set of small parts and a
set of rules which decide the ways in which these parts
can be combined to produce messages that have
meaning.</rdfs:comment>
<rdfs:comment xml:lang="fr">Systeme de representation
symbolique pour la communication se composant d un
ensemble de petits elements et d un ensemble de regles qui
regissent la facon selon laquelle ces pieces peuvent etre
combinees pour produire des messages qui ont une
signification.</rdfs:comment>
<rdfs:label xml:lang="en">language</rdfs:label>
<rdfs:label xml:lang="en">tongue</rdfs:label>
<rdfs:label xml:lang="fr">langage</rdfs:label>
<rdfs:label xml:lang="fr">langue</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ArtificialLanguage">
<rdfs:subClassOf rdf:resource="#Language"/>
<rdfs:comment xml:lang="en">Language that has been
explicitly developed at a specific time, rather than
evolving naturally over time through use by a community.
It is usually designed for a specific
purpose.</rdfs:comment>
<rdfs:comment xml:lang="fr">Langage qui a ete
explicitement developpe a une periode specifique, plutot
que d evoluer naturellement avec le temps et a travers l
utilisation d une communaute. Il est habituellement concu
dans un but specifique.</rdfs:comment>
<rdfs:label xml:lang="en">artificial language</rdfs:label>
<rdfs:label xml:lang="fr">langage artificiel</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ProgrammingLanguage">
<rdfs:subClassOf rdf:resource="#ArtificialLanguage"/>
<rdfs:comment xml:lang="en">Artificial Language for
instructing a computer to perform specific
tasks.</rdfs:comment>
<rdfs:comment xml:lang="fr">Langage artificiel pour
decrire, a un ordinateur, des taches a
accomplir.</rdfs:comment>
<rdfs:label xml:lang="en">programming
language</rdfs:label>
<rdfs:label xml:lang="en">programing language</rdfs:label>
<rdfs:label xml:lang="fr">langage de
programmation</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="LowLevelLanguage">
<rdfs:subClassOf rdf:resource="#ProgrammingLanguage"/>
<rdfs:comment xml:lang="en">Programming Language that is
closer to the hardware than are High-level Languages,
which are closer to human languages.</rdfs:comment>
<rdfs:comment xml:lang="fr">Langage de Programmation plus
pres du materiel que les langages de haut niveau, qui sont
plus pres des langages humains</rdfs:comment>
<rdfs:label xml:lang="en">low level language</rdfs:label>
<rdfs:label xml:lang="fr">langage de bas
niveau</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MachineLanguage">
<rdfs:subClassOf rdf:resource="#LowLevelLanguage"/>
<rdfs:comment xml:lang="en">The lowest-level Programming
Language that consistw entirely of numbers.</rdfs:comment>
<rdfs:comment xml:lang="fr">Le langage de programmation de
plus bas-niveau qui consiste entierement en des
nombres.</rdfs:comment>
<rdfs:label xml:lang="en">machine language</rdfs:label>
<rdfs:label xml:lang="fr">langage machine</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="AssemblyLanguage">
<rdfs:subClassOf rdf:resource="#LowLevelLanguage"/>
<rdfs:comment xml:lang="en">Low-level Language that
contains the same instructions as a Machine Language, but
the instructions and variables have names instead of being
just numbers.</rdfs:comment>
<rdfs:comment xml:lang="fr">Langage de bas niveau qui
contient les memes instructions qu un langage machine,
mais les instructions et les variables ont des noms au
lieu d etre juste des nombres.</rdfs:comment>
<rdfs:label xml:lang="en">assembly language</rdfs:label>
<rdfs:label xml:lang="fr">assembleur</rdfs:label>
<rdfs:label xml:lang="fr">langage assembleur</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="HighLevelLanguage">
<rdfs:subClassOf rdf:resource="#ProgrammingLanguage"/>
<rdfs:comment xml:lang="en">Programming Language that
enables a programmer to write programs that are more or
less independent of a particular type of computer. Such
languages are considered high-level because they are
closer to human languages than are Low-level Languages,
which are closer to machine languages.</rdfs:comment>
<rdfs:comment xml:lang="fr">Langage de programmation qui
permet a un programmeur d ecrire des programmes plus ou
moins independants d un type particulier d ordinateur. De
tels langages sont consideres de haut niveau parce qu ils
sont plus pres des langages humains que les langages de
bas niveau, qui sont plus pres des langages
machine.</rdfs:comment>
<rdfs:label xml:lang="en">high level language</rdfs:label>
<rdfs:label xml:lang="fr">langage de haut
niveau</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="UML">
<rdfs:subClassOf rdf:resource="#ArtificialLanguage"/>
<rdfs:comment xml:lang="en">General-purpose notational
Artificial Language for specifying and visualizing complex
software, especially large, object-oriented
projects.</rdfs:comment>
<rdfs:comment xml:lang="fr">Langage artificiel, notation
universelle, pour specifier et visualiser des logiciels
complexes, particulierement de grands projets orientes
objet.</rdfs:comment>
<rdfs:label xml:lang="en">UML</rdfs:label>
<rdfs:label xml:lang="en">U.M.L.</rdfs:label>
<rdfs:label xml:lang="en">unified modeling
language</rdfs:label>
<rdfs:label xml:lang="fr">UML</rdfs:label>
<rdfs:label xml:lang="fr">U.M.L.</rdfs:label>
<rdfs:label xml:lang="fr">langage de modelisation
universel</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="NaturalLanguage">
<rdfs:subClassOf rdf:resource="#Language"/>
<rdfs:comment xml:lang="en">Language used by human beings,
which has evolved  naturally.</rdfs:comment>
<rdfs:comment xml:lang="fr">Langage employe par les etres
humains, qui a evolue naturellement. </rdfs:comment>
```

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<rdfs:label xml:lang="en">natural language</rdfs:label>
<rdfs:label xml:lang="fr">langue naturelle</rdfs:label>
<rdfs:label xml:lang="fr">langage naturel</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="English">
<rdfs:subClassOf rdf:resource="#NaturalLanguage"/>
<rdfs:comment xml:lang="en">Natural Language spoken by the
natives of England.</rdfs:comment>
<rdfs:comment xml:lang="fr">Langue naturelle parlee par la
population autochtone d Angleterre.</rdfs:comment>
<rdfs:label xml:lang="en">English</rdfs:label>
<rdfs:label xml:lang="fr">Anglais</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="American">
<rdfs:subClassOf rdf:resource="#English"/>
<rdfs:comment xml:lang="en">English spoken by the natives
of American.</rdfs:comment>
<rdfs:comment xml:lang="fr">Anglais parle par la
population autochtone des Etats-Unis.</rdfs:comment>
<rdfs:label xml:lang="en">American</rdfs:label>
<rdfs:label xml:lang="fr">Americain</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="French">
<rdfs:subClassOf rdf:resource="#NaturalLanguage"/>
<rdfs:comment xml:lang="en">Natural Language spoken by the
natives of France.</rdfs:comment>
<rdfs:comment xml:lang="fr">Langue naturelle parlee par la
population autochtone de France.</rdfs:comment>
<rdfs:label xml:lang="en">French</rdfs:label>
<rdfs:label xml:lang="fr">Francais</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="German">
<rdfs:subClassOf rdf:resource="#NaturalLanguage"/>
<rdfs:comment xml:lang="en">Natural Language spoken by the
natives of Germany.</rdfs:comment>
<rdfs:comment xml:lang="fr">Langue naturelle parlee par la
population autochtone d Allemagne.</rdfs:comment>
<rdfs:label xml:lang="en">German</rdfs:label>
<rdfs:label xml:lang="fr">Allemand</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Italian">
<rdfs:subClassOf rdf:resource="#NaturalLanguage"/>
<rdfs:comment xml:lang="en">Natural Language spoken by the
natives of Italy.</rdfs:comment>
<rdfs:comment xml:lang="fr">Langue naturelle parlee par la
population autochtone d Italie.</rdfs:comment>
<rdfs:label xml:lang="en">Italian</rdfs:label>
<rdfs:label xml:lang="fr">Italien</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Spanish">
<rdfs:subClassOf rdf:resource="#NaturalLanguage"/>
<rdfs:comment xml:lang="en">Natural Language spoken by the
natives of Spain.</rdfs:comment>
<rdfs:comment xml:lang="fr">Langue naturelle parlee par la
population autochtone d Espagne.</rdfs:comment>
<rdfs:label xml:lang="en">Spanish</rdfs:label>
<rdfs:label xml:lang="fr">Espagnol</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SignLanguage">
<rdfs:subClassOf rdf:resource="#NaturalLanguage"/>
<rdfs:comment xml:lang="en">Natural Language expressed by
visible hand gestures.</rdfs:comment>
<rdfs:comment xml:lang="fr">Langue naturelle s exprimant
par des gestes visibles.</rdfs:comment>
<rdfs:label xml:lang="en">sign language</rdfs:label>
<rdfs:label xml:lang="fr">langage des signes</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MusicalLanguage">
<rdfs:subClassOf rdf:resource="#Language"/>
<rdfs:comment xml:lang="en">Natural Language representing
musical notes.</rdfs:comment>
<rdfs:comment xml:lang="fr">Langue naturelle representant
des notes de musiques.</rdfs:comment>
<rdfs:label xml:lang="en">musical language</rdfs:label>
<rdfs:label xml:lang="fr">langage musical</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="IndexicalRepresentationSystem">
<rdfs:subClassOf
rdf:resource="#DocumentaryRepresentationSystem"/>
<rdfs:comment xml:lang="en">Representation System  based
on indices that are physically connected with the object
they represents - e.g. smoke and fire.</rdfs:comment>
<rdfs:comment xml:lang="fr">Systeme de representation base
sur des indices qui sont physiquement relies a l objet qu
ils representent - par exemple la fumee et le
feu.</rdfs:comment>
<rdfs:label xml:lang="en">indexical representation
system</rdfs:label>
<rdfs:label xml:lang="fr">systeme de representation par
indice</rdfs:label>
</rdfs:Class>


<!-- document storage inscription format -->

<rdfs:Class rdf:ID="StorageFormat">
<rdfs:subClassOf rdf:resource="#DocumentAttribute"/>
<rdfs:comment xml:lang="en">A particular arrangement to
hold and retain data.</rdfs:comment>
<rdfs:comment xml:lang="fr">Un agencement particulier pour
l enregistrement et la sauvegarde de
donnees.</rdfs:comment>
<rdfs:label xml:lang="en">storage format</rdfs:label>
<rdfs:label xml:lang="fr">format de stockage</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="AnalogFormat">
<rdfs:subClassOf rdf:resource="#StorageFormat"/>
<rdfs:comment xml:lang="en">Storage format based on
continuous data.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format de stockage base sur
des donnees continues.</rdfs:comment>
<rdfs:label xml:lang="en">analog format</rdfs:label>
<rdfs:label xml:lang="fr">format analogique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="DigitalFormat">
<rdfs:subClassOf rdf:resource="#StorageFormat"/>
<rdfs:comment xml:lang="en">Storage format based on
discontinuous data.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format de stockage base sur
des donnees discontinues.</rdfs:comment>
<rdfs:label xml:lang="en">digital format</rdfs:label>
<rdfs:label xml:lang="en">numeric format</rdfs:label>
<rdfs:label xml:lang="fr">format numerique</rdfs:label>
<rdfs:label xml:lang="fr">format digital</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="CDAudioTrack">
<rdfs:subClassOf rdf:resource="#DigitalFormat"/>
<rdfs:comment xml:lang="en">Digital format used for audio
track on compact discs.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format numerique utilise pour
une piste sur les disques compacts audio.</rdfs:comment>
<rdfs:label xml:lang="en">CD audio track</rdfs:label>
<rdfs:label xml:lang="fr">piste de CD audio</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ComputerFileFormat">
<rdfs:subClassOf rdf:resource="#DigitalFormat"/>
<rdfs:comment xml:lang="en">Digital format corresponding
to a single collection of computer data or information
that has a name.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format numerique correspondant
a un ensemble nommé de donnees ou d informations d
ordinateur.</rdfs:comment>
<rdfs:label xml:lang="en">computer file
format</rdfs:label>
<rdfs:label xml:lang="fr">format de fichier
informatique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ExecutableFormat">
<rdfs:subClassOf rdf:resource="#ComputerFileFormat"/>
<rdfs:comment xml:lang="en">Computer File Format of a
program that can be executed by a computer.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format de fichier informatique
d un programme qui peut etre execute par un
ordinateur.</rdfs:comment>
<rdfs:label xml:lang="en">executable format</rdfs:label>
<rdfs:label xml:lang="en">EXE</rdfs:label>
<rdfs:label xml:lang="fr">format executable</rdfs:label>
<rdfs:label xml:lang="fr">EXE</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="DataFileFormat">
<rdfs:subClassOf rdf:resource="#ComputerFileFormat"/>
<rdfs:comment xml:lang="en">Computer File format dedicated
and formatted to be manipulated by a
Program.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format de fichier informatique
consacre a et formate pour etre manipule par un
programme.</rdfs:comment>
<rdfs:label xml:lang="en">data file format</rdfs:label>
<rdfs:label xml:lang="fr">format fichier de
donnees</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="TextFormat">
<rdfs:subClassOf rdf:resource="#DataFileFormat"/>
<rdfs:comment xml:lang="en">Data file format storing data
in ASCII.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format fichier de donnees
enregistrant des donnees en ASCII.</rdfs:comment>
<rdfs:label xml:lang="en">text format</rdfs:label>
<rdfs:label xml:lang="fr">format texte</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="HTMLFormat">
<rdfs:subClassOf rdf:resource="#TextFormat"/>
<rdfs:comment xml:lang="en">Text Format of a Documentary
Element written in HyperText Markup
Language.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format texte de documents
utilisant le langage de marqueurs
hypertexte.</rdfs:comment>
<rdfs:label xml:lang="en">HTML</rdfs:label>
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<rdfs:label xml:lang="en">H.T.M.L.</rdfs:label>
<rdfs:label xml:lang="en">H.T.M.L. format</rdfs:label>
<rdfs:label xml:lang="en">HyperText Markup Language
format</rdfs:label>
<rdfs:label xml:lang="fr">HTML</rdfs:label>
<rdfs:label xml:lang="fr">H.T.M.L.</rdfs:label>
<rdfs:label xml:lang="fr">format H.T.M.L.</rdfs:label>
<rdfs:label xml:lang="fr">format Langage de Marqueurs
HyperTexte</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="XMLFormat">
<rdfs:subClassOf rdf:resource="#TextFormat"/>
<rdfs:comment xml:lang="en">Text Format of a Documentary
Element written in eXtensible Markup
Language.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format texte de documents
utilisant le langage de marqueurs
extensible.</rdfs:comment>
<rdfs:label xml:lang="en">XML</rdfs:label>
<rdfs:label xml:lang="en">X.M.L.</rdfs:label>
<rdfs:label xml:lang="en">X.M.L. Format</rdfs:label>
<rdfs:label xml:lang="en">Extensible Markup Language
Format</rdfs:label>
<rdfs:label xml:lang="fr">XML</rdfs:label>
<rdfs:label xml:lang="fr">X.M.L.</rdfs:label>
<rdfs:label xml:lang="fr">format X.M.L.</rdfs:label>
<rdfs:label xml:lang="en">format du Langage de Marqueurs
Extensible</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="AIFFFormat">
<rdfs:subClassOf rdf:resource="#DataFileFormat"/>
<rdfs:comment xml:lang="en">Data File Format of audio
documents encoded in Audio Interchange File
Format.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format de fichier de donnees
des documents audio encodes suivant le Format d Echange de
Fichiers Audio -AIFF-.</rdfs:comment>
<rdfs:label xml:lang="en">AIFF </rdfs:label>
<rdfs:label xml:lang="en">A.I.F.F.</rdfs:label>
<rdfs:label xml:lang="en">Audio Interchange File
Format</rdfs:label>
<rdfs:label xml:lang="fr">AIFF </rdfs:label>
<rdfs:label xml:lang="fr">A.I.F.F.</rdfs:label>
<rdfs:label xml:lang="fr">Format d Echange de Fichiers
Audio</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PSFormat">
<rdfs:subClassOf rdf:resource="#DataFileFormat"/>
<rdfs:comment xml:lang="en">Data File Format of a visual
document encoded in Postscript format.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format de fichier de donnees d
un document visuel encode dans le format Post-Scriptum -PS
postscript-.</rdfs:comment>
<rdfs:label xml:lang="en">PS</rdfs:label>
<rdfs:label xml:lang="en">P.S.</rdfs:label>
<rdfs:label xml:lang="en">P.S. format</rdfs:label>
<rdfs:label xml:lang="en">postscript</rdfs:label>
<rdfs:label xml:lang="en">Post Script Format</rdfs:label>
<rdfs:label xml:lang="fr">PS</rdfs:label>
<rdfs:label xml:lang="fr">P.S.</rdfs:label>
<rdfs:label xml:lang="fr">format P.S.</rdfs:label>
<rdfs:label xml:lang="fr">postscript</rdfs:label>
<rdfs:label xml:lang="fr">format Post-
Scriptum</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PDFFormat">
<rdfs:subClassOf rdf:resource="#DataFileFormat"/>
<rdfs:comment xml:lang="en">Data File Format of a visual
document encoded in Adobe Portable Document
Format.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format de fichier de donnees
pour un document visuel encode dans le format de document
portable d Adobe.</rdfs:comment>
<rdfs:label xml:lang="en">PDF</rdfs:label>
<rdfs:label xml:lang="en">P.D.F.</rdfs:label>
<rdfs:label xml:lang="en">P.D.F. format</rdfs:label>
<rdfs:label xml:lang="en">Portable Document
Format</rdfs:label>
<rdfs:label xml:lang="fr">PDF</rdfs:label>
<rdfs:label xml:lang="fr">P.D.F.</rdfs:label>
<rdfs:label xml:lang="fr">format P.D.F.</rdfs:label>
<rdfs:label xml:lang="fr">Format de Document
Portable</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ZIPFormat">
<rdfs:subClassOf rdf:resource="#DataFileFormat"/>
<rdfs:comment xml:lang="en">Data File Format for files
compressed in ZIP format.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format de fichier de donnees
pour des fichiers comprimes au format ZIP - Fermeture
eclaire -.</rdfs:comment>
<rdfs:label xml:lang="en">zip</rdfs:label>
<rdfs:label xml:lang="en">zip format</rdfs:label>
<rdfs:label xml:lang="fr">zip</rdfs:label>
<rdfs:label xml:lang="fr">format zip</rdfs:label>
<rdfs:label xml:lang="fr">format fermeture
eclaire</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="GIFFormat">
<rdfs:subClassOf rdf:resource="#DataFileFormat"/>
<rdfs:comment xml:lang="en">Data File Format of a visual
document compressed in Graphics Interchange
Format.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format de fichier de donnees d
un document visuel comprime au format d echange de
graphiques -GIF-.</rdfs:comment>
<rdfs:label xml:lang="en">GIF</rdfs:label>
<rdfs:label xml:lang="en">G.I.F.</rdfs:label>
<rdfs:label xml:lang="en">graphics interchange
format</rdfs:label>
<rdfs:label xml:lang="fr">GIF</rdfs:label>
<rdfs:label xml:lang="fr">G.I.F.</rdfs:label>
<rdfs:label xml:lang="fr">format d echange de
graphiques</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="JPEGFormat">
<rdfs:subClassOf rdf:resource="#DataFileFormat"/>
<rdfs:comment xml:lang="en">Data File Format of a visual
document compressed in Joint Photographic Experts Group
format.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format de fichier de donnees d
un document visuel comprime au format commun du groupe d
experts photographiques -JPEG-.</rdfs:comment>
<rdfs:label xml:lang="en">JPEG</rdfs:label>
<rdfs:label xml:lang="en">J.P.E.G.</rdfs:label>
<rdfs:label xml:lang="en">J.P.E.G. format</rdfs:label>
<rdfs:label xml:lang="en">joint photographic experts group
format</rdfs:label>
<rdfs:label xml:lang="fr">JPEG</rdfs:label>
<rdfs:label xml:lang="fr">J.P.E.G.</rdfs:label>
<rdfs:label xml:lang="fr">format J.P.E.G.</rdfs:label>
<rdfs:label xml:lang="fr">format Commun du Groupe d
Experts Photographiques</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MPEGFormat">
<rdfs:subClassOf rdf:resource="#DataFileFormat"/>
<rdfs:comment xml:lang="en">Data File Format of animated
images/movie compressed in Moving Picture Experts Group
format.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format de fichier de donnees d
images animees/films comprimes au format du groupe d
experts en images animees.</rdfs:comment>
<rdfs:label xml:lang="en">MPEG</rdfs:label>
<rdfs:label xml:lang="en">M.P.E.G.</rdfs:label>
<rdfs:label xml:lang="en">M.P.E.G. format</rdfs:label>
<rdfs:label xml:lang="en">moving picture experts group
format</rdfs:label>
<rdfs:label xml:lang="fr">MPEG</rdfs:label>
<rdfs:label xml:lang="fr">M.P.E.G.</rdfs:label>
<rdfs:label xml:lang="fr">M.P.E.G. format</rdfs:label>
<rdfs:label xml:lang="fr">format du groupe d experts en
images animees</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MP3Format">
<rdfs:subClassOf rdf:resource="#MPEGFormat"/>
<rdfs:comment xml:lang="en">MPEG Format of a audio
documents encoded according to the third coding schemes of
MPEG.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format MPEG des documents
audio encodes selon la troisieme version du codage
MPEG.</rdfs:comment>
<rdfs:label xml:lang="en">MP3</rdfs:label>
<rdfs:label xml:lang="en">M.P.3</rdfs:label>
<rdfs:label xml:lang="en">MP3 format</rdfs:label>
<rdfs:label xml:lang="fr">MP3</rdfs:label>
<rdfs:label xml:lang="fr">M.P.3</rdfs:label>
<rdfs:label xml:lang="fr">format MP3</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MSWordFormat">
<rdfs:subClassOf rdf:resource="#DataFileFormat"/>
<rdfs:comment xml:lang="en">Data File Format of a visual
document encoded in the format of Microsoft
Word.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format de fichier de donnees d
un document visuel encode dans le format de Microsoft
Word.</rdfs:comment>
<rdfs:label xml:lang="en">Word</rdfs:label>
<rdfs:label xml:lang="en">Word format</rdfs:label>
<rdfs:label xml:lang="en">Microsoft Word
format</rdfs:label>
<rdfs:label xml:lang="fr">Word</rdfs:label>
<rdfs:label xml:lang="fr">format Word</rdfs:label>
<rdfs:label xml:lang="fr">format Microsoft
Word</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MSExcelFormat">
<rdfs:subClassOf rdf:resource="#DataFileFormat"/>
<rdfs:comment xml:lang="en">Data File Format of a visual
document encoded in the format of Microsoft Excel
workbook.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format de fichier de donnees d
un document visuel encode au format d un classeur
Microsoft Excel.</rdfs:comment>
<rdfs:label xml:lang="en">Excel</rdfs:label>
<rdfs:label xml:lang="en">Excel format</rdfs:label>
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<rdfs:label xml:lang="en">Microsoft Excel
format</rdfs:label>
<rdfs:label xml:lang="fr">Excel</rdfs:label>
<rdfs:label xml:lang="fr">format Excel</rdfs:label>
<rdfs:label xml:lang="fr">format Microsoft
Excel</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="WAVFormat">
<rdfs:subClassOf rdf:resource="#DataFileFormat"/>
<rdfs:comment xml:lang="en">Data File Format of a audio
document encoded in the WAV format.</rdfs:comment>
<rdfs:comment xml:lang="fr">Format de fichier de donnees d
un document audio encode au format WAV.</rdfs:comment>
<rdfs:label xml:lang="en">wav</rdfs:label>
<rdfs:label xml:lang="en">WAV Format</rdfs:label>
<rdfs:label xml:lang="fr">wav</rdfs:label>
<rdfs:label xml:lang="fr">format WAV</rdfs:label>
</rdfs:Class>

<!-- Diffusion rights-->

<rdfs:Class rdf:ID="DiffusionRight">
<rdfs:subClassOf rdf:resource="#DocumentAttribute"/>
<rdfs:comment xml:lang="en">Authorized scope for the
diffusion of a document.</rdfs:comment>
<rdfs:comment xml:lang="fr">Porte autorisee pour la
diffusion d un document</rdfs:comment>
<rdfs:label xml:lang="en">diffusion right</rdfs:label>
<rdfs:label xml:lang="fr">droits de diffusion</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PublicDocument">
<rdfs:subClassOf rdf:resource="#DiffusionRight"/>
<rdfs:comment xml:lang="en">The diffusion is not subjected
to any restriction.</rdfs:comment>
<rdfs:comment xml:lang="fr">La diffusion n est sujette a
aucune restriction.</rdfs:comment>
<rdfs:label xml:lang="en">public document</rdfs:label>
<rdfs:label xml:lang="fr">document public</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ConfidentialDocument">
<rdfs:subClassOf rdf:resource="#DiffusionRight"/>
<rdfs:comment xml:lang="en">The diffusion is restricted to
a defined community. There are different levels of
confidentiality for internal or external diffusion. A
document can be composed of confidential parts or not
confidential parts (for example: the reference and the
abstract can be freely diffused but not the integral
text).</rdfs:comment>
<rdfs:comment xml:lang="fr">La diffusion est limitee a
une communaute definie. Il y a differents niveaux de
confidentialite pour la diffusion interne ou externe. Un
document peut se composer de parties confidentielles ou
non - par exemple: la reference et l e resume peuvent etre
librement diffuses mais pas le texte
integral.</rdfs:comment>
<rdfs:label xml:lang="en">confidential
document</rdfs:label>
<rdfs:label xml:lang="fr">document
confidentiel</rdfs:label>
</rdfs:Class>

<!-- Origin of a document -->

<rdfs:Class rdf:ID="DocumentOrign">
<rdfs:subClassOf rdf:resource="#DocumentAttribute"/>
<rdfs:comment xml:lang="en">Where the document was
produced or written.</rdfs:comment>
<rdfs:comment xml:lang="fr">Ou le document a ete produit
ou ecrit.</rdfs:comment>
<rdfs:label xml:lang="en">document orign</rdfs:label>
<rdfs:label xml:lang="fr">origine du document</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="InternalDocument">
<rdfs:subClassOf rdf:resource="#DiffusionRight"/>
<rdfs:comment xml:lang="en">The document was produced in-
house..</rdfs:comment>
<rdfs:comment xml:lang="fr">Document a ete produit en
interne.</rdfs:comment>
<rdfs:label xml:lang="en">internal document</rdfs:label>
<rdfs:label xml:lang="fr">document interne</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ExternalDocument">
<rdfs:subClassOf rdf:resource="#DiffusionRight"/>
<rdfs:comment xml:lang="en">Document acquired from an
external source and not written in-house.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document venant d une source
exterieure et non ecrit en interne. </rdfs:comment>
<rdfs:label xml:lang="en">external document</rdfs:label>
<rdfs:label xml:lang="fr">document externe</rdfs:label>
</rdfs:Class>

<!-- Activities -->

<rdfs:Class rdf:ID="Activity">
<rdfs:subClassOf rdf:resource="#NonSpatialEntity"/>
<rdfs:comment xml:lang="en">Entity representing a type of
voluntary action.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite representant un type d
action volontaire.</rdfs:comment>
<rdfs:label xml:lang="en">activity</rdfs:label>
<rdfs:label xml:lang="fr">activite</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MakeSomething">
<rdfs:subClassOf rdf:resource="#Activity"/>
<rdfs:comment xml:lang="en">Activity in which something -
tangible - is made from some raw materials.</rdfs:comment>
<rdfs:comment xml:lang="fr">Activite dans laquelle quelque
chose - de reel - est fait a  partir de matieres
premieres.</rdfs:comment>
<rdfs:label xml:lang="en">make something</rdfs:label>
<rdfs:label xml:lang="fr">creer quelque chose</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Manufacturing">
<rdfs:subClassOf rdf:resource="#MakeSomething"/>
<rdfs:comment xml:lang="en">Make Something from raw
materials or component parts that are combined to produce
a product.</rdfs:comment>
<rdfs:comment xml:lang="fr">Faire quelque chose a  partir
de matieres premieres ou d elements combinables pour
produire un produit.</rdfs:comment>
<rdfs:label xml:lang="en">manufacture</rdfs:label>
<rdfs:label xml:lang="fr">fabriquer</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Business">
<rdfs:subClassOf rdf:resource="#Activity"/>
<rdfs:comment xml:lang="en">Activity composed of
commercial or industrial activities intended to make
profits.</rdfs:comment>
<rdfs:comment xml:lang="fr">Activite composee d activites
commerciales ou industrielles cherchant a degager des
benefices.</rdfs:comment>
<rdfs:label xml:lang="en">business</rdfs:label>
<rdfs:label xml:lang="fr">affaires</rdfs:label>
<rdfs:label xml:lang="fr">business</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MedicalCare">
<rdfs:subClassOf rdf:resource="#Activity"/>
<rdfs:comment xml:lang="en">Activity of medical care of
patients, including surgery, psychological care, physical
therapy, practical nursing, and dispensing
drugs.</rdfs:comment>
<rdfs:comment xml:lang="fr">Activite de soins medicaux des
patients comprenant en particulier la chirurgie, le soin
psychologique, la therapie physique, les soins infirmiers,
et la distribution de medicaments.</rdfs:comment>
<rdfs:label xml:lang="en">medical care</rdfs:label>
<rdfs:label xml:lang="fr">soins medicaux</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Art">
<rdfs:subClassOf rdf:resource="#Activity"/>
<rdfs:comment xml:lang="en">Activity through which people
express particular ideas, the making of what is expressive
or beautiful.</rdfs:comment>
<rdfs:comment xml:lang="fr">Activite par laquelle les gens
expriment des idees particulieres, fabrication de ce qui
est expressif ou beau.</rdfs:comment>
<rdfs:label xml:lang="en">art</rdfs:label>
<rdfs:label xml:lang="fr">art</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Service">
<rdfs:subClassOf rdf:resource="#Activity"/>
<rdfs:comment xml:lang="en">Activity where a work is done
by one person or group that benefits
another.</rdfs:comment>
<rdfs:comment xml:lang="fr">Activite ou un travail est
effectue par une personne ou un groupe et beneficie d
autres.</rdfs:comment>
<rdfs:label xml:lang="en">service</rdfs:label>
<rdfs:label xml:lang="fr">service</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Administration">
<rdfs:subClassOf rdf:resource="#Service"/>
<rdfs:comment xml:lang="en">Service of supervision and
control of the operations or arrangement of an
Organizational Entity.</rdfs:comment>
<rdfs:comment xml:lang="fr">Forme de service de gestion et
de controle des operations ou de l agencement d une entite
organisationnelle.</rdfs:comment>
<rdfs:comment xml:lang="fr"></rdfs:comment>
<rdfs:label xml:lang="en">administration</rdfs:label>
<rdfs:label xml:lang="en">administer</rdfs:label>
<rdfs:label xml:lang="fr">administration</rdfs:label>
<rdfs:label xml:lang="fr">administrer</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Finance">
<rdfs:subClassOf rdf:resource="#Service"/>
<rdfs:comment xml:lang="en">Service concerned with buying,
selling, trading, converting, or lending money, in the
form of currency or negotiable financial instruments -such
as stocks, bonds, commodities futures, etc.-
</rdfs:comment>
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<rdfs:comment xml:lang="fr">Forme de service concerne par
l achat, la vente, les transaction commerciales, la
convertion, ou le pret d argent, sous forme de devise ou d
instruments financiers negociables - tels que des actions,
des obligations, etc. -</rdfs:comment>
<rdfs:label xml:lang="en">finance</rdfs:label>
<rdfs:label xml:lang="fr">finance</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Payroll">
<rdfs:subClassOf rdf:resource="#Finance"/>
<rdfs:comment xml:lang="en">Finance activity concerned
with maintaining the list of the people employed, showing
the total amount of money paid to the people employed by a
particular company.</rdfs:comment>
<rdfs:comment xml:lang="fr">Activite financiere concernee
par la mise a jour de la liste des personnes employees,
montrant le montant total d argent paye aux personnes
employees par une compagnie donnee.</rdfs:comment>
<rdfs:label xml:lang="en">payroll</rdfs:label>
<rdfs:label xml:lang="fr">registre du
personnel</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Banking">
<rdfs:subClassOf rdf:resource="#Finance"/>
<rdfs:comment xml:lang="en">Finance activity concerned
with deposits, channeling money into lending activities,
providing services for investing money, borrowing money or
changing money to foreign currency.</rdfs:comment>
<rdfs:comment xml:lang="fr">Activite financiere concernee
par le depot, l orientation de l argent vers des activites
de pret, en fournissant des services pour investir de l
argent, emprunter de l argent ou changer l argent en
devises etrangeres. </rdfs:comment>
<rdfs:label xml:lang="en">banking</rdfs:label>
<rdfs:label xml:lang="fr">operations
bancaires</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Marketing">
<rdfs:subClassOf rdf:resource="#Service"/>
<rdfs:comment xml:lang="en">Service by which a product or
service is sold, including assessment of its sales
potential and responsibility for its promotion and
distribution.</rdfs:comment>
<rdfs:comment xml:lang="fr">Service par lequel un produit
ou un service est vendu, comprennant en particulier l
evaluation de son potentiel de vente et la responsabilite
de sa promotion et sa distribution.</rdfs:comment>
<rdfs:label xml:lang="en">marketing</rdfs:label>
<rdfs:label xml:lang="fr">marketing</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Commerce">
<rdfs:subClassOf rdf:resource="#Service"/>
<rdfs:comment xml:lang="en">Activity concerned with buying
or selling goods or services for a profit.</rdfs:comment>
<rdfs:comment xml:lang="fr">Activite concernee par l achat
ou la vente de marchandise ou de service pour en retirer
un benefice.</rdfs:comment>
<rdfs:label xml:lang="en">commerce</rdfs:label>
<rdfs:label xml:lang="fr">commerce</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Advertise">
<rdfs:subClassOf rdf:resource="#Service"/>
<rdfs:comment xml:lang="en">Activity consisting in making
something known in order to sell it.</rdfs:comment>
<rdfs:comment xml:lang="fr">Activite consistant a faire
connaitre quelque chose afin de la vendre.</rdfs:comment>
<rdfs:label xml:lang="en">advertise</rdfs:label>
<rdfs:label xml:lang="en">advertising</rdfs:label>
<rdfs:label xml:lang="en">advertisement</rdfs:label>
<rdfs:label xml:lang="fr">publicite</rdfs:label>
<rdfs:label xml:lang="fr">faire de la
publicite</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Sell">
<rdfs:subClassOf rdf:resource="#Commerce"/>
<rdfs:comment xml:lang="en">Commerce activity where a
person or an organization gives a product or a service to
another in return for money.</rdfs:comment>
<rdfs:comment xml:lang="fr">Activite commerciale par
laquelle une personne ou une organisation donne un produit
ou un service a une autre en echange d une somme d
argent.</rdfs:comment>
<rdfs:label xml:lang="en">sale</rdfs:label>
<rdfs:label xml:lang="en">sell</rdfs:label>
<rdfs:label xml:lang="fr">vente</rdfs:label>
<rdfs:label xml:lang="fr">vendre</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Buy">
<rdfs:subClassOf rdf:resource="#Commerce"/>
<rdfs:comment xml:lang="en">Commerce activity where a
person or an organization obtains something by paying
money for it.</rdfs:comment>
<rdfs:comment xml:lang="fr">Activite commerciale par
laquelle une personne ou une organisation obtient quelque
chose en payant pour cela une somme d
argent.</rdfs:comment>
<rdfs:label xml:lang="en">buy</rdfs:label>
<rdfs:label xml:lang="en">purchase</rdfs:label>
<rdfs:label xml:lang="fr">achat</rdfs:label>
<rdfs:label xml:lang="fr">acheter</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Legal">
<rdfs:subClassOf rdf:resource="#Service"/>
<rdfs:comment xml:lang="en">Activity concerned by the
respect of the law.</rdfs:comment>
<rdfs:comment xml:lang="fr">Activite concernee par le
respect de la loi.</rdfs:comment>
<rdfs:label xml:lang="en">legal</rdfs:label>
<rdfs:label xml:lang="fr">legal</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Education">
<rdfs:subClassOf rdf:resource="#Service"/>
<rdfs:comment xml:lang="en">Service of teaching and/or
training.</rdfs:comment>
<rdfs:comment xml:lang="fr">Service d enseignement et/ou
de formation.</rdfs:comment>
<rdfs:label xml:lang="en">education</rdfs:label>
<rdfs:label xml:lang="fr">education</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Teach">
<rdfs:subClassOf rdf:resource="#Education"/>
<rdfs:comment xml:lang="en">Activity in which some people
impart learned knowledge to others.</rdfs:comment>
<rdfs:comment xml:lang="fr">Activite par laquelle une
personne communique, a d autres personnes, des
connaissances apprises.</rdfs:comment>
<rdfs:label xml:lang="en">teach</rdfs:label>
<rdfs:label xml:lang="en">teaching</rdfs:label>
<rdfs:label xml:lang="fr">enseigner</rdfs:label>
<rdfs:label xml:lang="fr">enseignement</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Research">
<rdfs:subClassOf rdf:resource="#Service"/>
<rdfs:comment xml:lang="en">Service providing detailed
study of a subject, esp. in order to discover -new-
information or reach a -new- understanding.</rdfs:comment>
<rdfs:comment xml:lang="fr">Service founissant l etude
detaillee d un sujet, afin de decouvrir en particulier de
- nouvelles - informations ou atteindre une - nouvelle -
comprehension.</rdfs:comment>
<rdfs:label xml:lang="en">research</rdfs:label>
<rdfs:label xml:lang="fr">recherche</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Academic">
<rdfs:subClassOf rdf:resource="#Education"/>
<rdfs:subClassOf rdf:resource="#Research"/>
<rdfs:comment xml:lang="en">Activity of education and/or
research usually affiliated to academic
institution.</rdfs:comment>
<rdfs:comment xml:lang="fr">Activite d education et/ou de
recherche habituellement affiliee a l
universite.</rdfs:comment>
<rdfs:label xml:lang="en">academic</rdfs:label>
<rdfs:label xml:lang="fr">universitaire</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Travel">
<rdfs:subClassOf rdf:resource="#Service"/>
<rdfs:comment xml:lang="en">Service giving information
about prices and schedules for a trip and arranging
tickets and accommodation.</rdfs:comment>
<rdfs:comment xml:lang="fr">Service fournissant des
informations sur les prix et les programmes de voyage, se
chargeant des billets voire du logement. </rdfs:comment>
<rdfs:label xml:lang="en">travel</rdfs:label>
<rdfs:label xml:lang="fr">voyage</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Transport">
<rdfs:subClassOf rdf:resource="#Service"/>
<rdfs:comment xml:lang="en">Service of providing
transportation of goods or persons.</rdfs:comment>
<rdfs:comment xml:lang="fr">Service proposant le
deplacement de marchandises ou de
personnes.</rdfs:comment>
<rdfs:label xml:lang="en">transport</rdfs:label>
<rdfs:label xml:lang="fr">transport</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Food">
<rdfs:subClassOf rdf:resource="#Service"/>
<rdfs:comment xml:lang="en">Service of preparing and/or
serving food.</rdfs:comment>
<rdfs:comment xml:lang="fr">Service de preparation et/ou
distribution de nourriture.</rdfs:comment>
<rdfs:label xml:lang="en">restoration</rdfs:label>
<rdfs:label xml:lang="en">food</rdfs:label>
<rdfs:label xml:lang="fr">restauration</rdfs:label>
<rdfs:label xml:lang="fr">nourriture</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Insurance">
<rdfs:subClassOf rdf:resource="#Service"/>
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<rdfs:comment xml:lang="en">Service of providing financial
and material protection to clients in the event of
sickness, death, natural disaster, loss, theft, lawsuits,
etc. </rdfs:comment>
<rdfs:comment xml:lang="fr">Service assurant la protection
financiere et materielle de ses clients en cas de la
maladie, de mort, de catastrophe naturelle, de perte, de
vol, de proces, etc...</rdfs:comment>
<rdfs:label xml:lang="en">insurance</rdfs:label>
<rdfs:label xml:lang="fr">assurance</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="HumanResources">
<rdfs:subClassOf rdf:resource="#Service"/>
<rdfs:comment xml:lang="en">Service of administration of
people, especially the skills and abilities they have, and
the job and position they occupy.</rdfs:comment>
<rdfs:comment xml:lang="fr">Service de gestion des
personnes, particulierement leurs qualifications et leurs
capacites, du travail et de la position qu ils
occupent.</rdfs:comment>
<rdfs:label xml:lang="en">human resources</rdfs:label>
<rdfs:label xml:lang="fr">ressources humaines</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Consulting">
<rdfs:subClassOf rdf:resource="#Service"/>
<rdfs:comment xml:lang="en">Service of providing
professional advice or expertise.</rdfs:comment>
<rdfs:comment xml:lang="fr">Service fournissant du conseil
ou de lexpertise professionnel.</rdfs:comment>
<rdfs:label xml:lang="en">consulting</rdfs:label>
<rdfs:label xml:lang="fr">consultance</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Development">
<rdfs:subClassOf rdf:resource="#Service"/>
<rdfs:comment xml:lang="en">Service corresponding to
analysis, design, implementation and testing of research
solutions.</rdfs:comment>
<rdfs:comment xml:lang="fr">Service consistant en l
analyse, la conception, l implantation et le test des
solutions de recherches. </rdfs:comment>
<rdfs:label xml:lang="en">development</rdfs:label>
<rdfs:label xml:lang="fr">developpement</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="QualityAssessment">
<rdfs:subClassOf rdf:resource="#Service"/>
<rdfs:comment xml:lang="en">Evaluation and certification
of products and process.</rdfs:comment>
<rdfs:comment xml:lang="fr">Evaluation et certification
des produits et des processus.</rdfs:comment>
<rdfs:label xml:lang="en">quality assessment</rdfs:label>
<rdfs:label xml:lang="fr">evaluation de
qualite</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="KnowledgeDissemination">
<rdfs:subClassOf rdf:resource="#Service"/>
<rdfs:comment xml:lang="en">Diffusing knowledge previously
acquired.</rdfs:comment>
<rdfs:comment xml:lang="fr">Diffuser la connaissance
prealablement acquise.</rdfs:comment>
<rdfs:label xml:lang="en">knowledge
dissemination</rdfs:label>
<rdfs:label xml:lang="fr">dissemination de la
connaissance</rdfs:label>
</rdfs:Class>

<!-- Additional Identified Topics of interest -->

<rdfs:Class rdf:ID="AdditionalTopic">
<rdfs:subClassOf rdf:resource="#Entity"/>
<rdfs:comment xml:lang="en">Entity representing subjects
that hold attention and possibly something one wants to
discover. These topics are additional in the sens that
they were not introduced or used anywhere else in the
ontology but were identified as relevant for document
annotation - domain concepts, general subjects...-
</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite representant des sujets
qui retiennent l attention et suceptibles d interesser les
utilisateurs. Ces sujets sont supplementaires au sens ou
ils n ont pas ete introduits ou utilises dans ailleurs
dans l ontology mais ont ete identifies comme appropries
pour l annotation de documents - concepts du domaine,
sujets generaux... - </rdfs:comment>
<rdfs:label xml:lang="en">additional topic</rdfs:label>
<rdfs:label xml:lang="fr">sujet
supplementaire</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MusicTopic">
<rdfs:subClassOf rdf:resource="#AdditionalTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">music</rdfs:label>
<rdfs:label xml:lang="fr">musique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="EarthObservationTopic">
<rdfs:subClassOf rdf:resource="#AdditionalTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">earth observation</rdfs:label>
<rdfs:label xml:lang="fr">observation de la
terre</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="CartographyTopic">
<rdfs:subClassOf rdf:resource="#EarthObservationTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">cartography</rdfs:label>
<rdfs:label xml:lang="fr">cartographie</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="BiologyTopic">
<rdfs:subClassOf rdf:resource="#AdditionalTopic"/>
<rdfs:comment xml:lang="en">The scientific study of the
natural processes of living things.</rdfs:comment>
<rdfs:comment xml:lang="fr">Etude scientifique des
processus naturels des choses de vie.</rdfs:comment>
<rdfs:label xml:lang="en">biology</rdfs:label>
<rdfs:label xml:lang="fr">biologie</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="AgricultureTopic">
<rdfs:subClassOf rdf:resource="#AdditionalTopic"/>
<rdfs:comment xml:lang="en">Science of cultivating the
soil, producing crops, and raising livestock;
farming.</rdfs:comment>
<rdfs:comment xml:lang="fr">Science de la culture du sol,
de la production et de la recolte, et de l elevage du
betail.</rdfs:comment>
<rdfs:label xml:lang="en">agriculture</rdfs:label>
<rdfs:label xml:lang="fr">agriculture</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="AquacultureTopic">
<rdfs:subClassOf rdf:resource="#AdditionalTopic"/>
<rdfs:comment xml:lang="en">Science, of cultivating marine
or freshwater food fish or shellfish, such as oysters,
clams, salmon, and trout, under controlled
conditions.</rdfs:comment>
<rdfs:comment xml:lang="fr">Science, de l elevage des
poissons comestibles ou des mollusques et crustaces marins
ou d eau douce, tels que des huitres, palourdes, saumons,
et truite, dans des conditions controlees.</rdfs:comment>
<rdfs:label xml:lang="en">aquaculture</rdfs:label>
<rdfs:label xml:lang="fr">aquaculture</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="VisualPerceptionTopic">
<rdfs:subClassOf rdf:resource="#BiologyTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">visual perception</rdfs:label>
<rdfs:label xml:lang="fr">perception visuelle</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PhysicsTopic">
<rdfs:subClassOf rdf:resource="#AdditionalTopic"/>
<rdfs:comment xml:lang="en">Science of matter and energy
and their interactions.</rdfs:comment>
<rdfs:comment xml:lang="fr">Science de la matiere et de l
energie et de leurs interactions.</rdfs:comment>
<rdfs:label xml:lang="en">physics</rdfs:label>
<rdfs:label xml:lang="fr">physique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MechanicsTopic">
<rdfs:subClassOf rdf:resource="#PhysicsTopic"/>
<rdfs:comment xml:lang="en">Study of the effect of
physical forces on objects and their
movement.</rdfs:comment>
<rdfs:comment xml:lang="fr">Etude de l effet des forces
physiques sur les objets et leur mouvement.</rdfs:comment>
<rdfs:label xml:lang="en">mechanics</rdfs:label>
<rdfs:label xml:lang="fr">mecanique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="WavePropagationTopic">
<rdfs:subClassOf rdf:resource="#PhysicsTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">wave propagation</rdfs:label>
<rdfs:label xml:lang="fr">propagation d ondes</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="LiquidMechanicsTopic">
<rdfs:subClassOf rdf:resource="#MechanicsTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">liquid mechanics</rdfs:label>
<rdfs:label xml:lang="fr">mecanique liquide</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MathematicsTopic">
<rdfs:subClassOf rdf:resource="#AdditionalTopic"/>
<rdfs:comment xml:lang="en">Topic concerned with the study
of numbers, shapes and space using reason and usually a
special system of symbols and rules for organizing
them.</rdfs:comment>
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<rdfs:comment xml:lang="fr">Sujet concerne par l etude des
nombres, des formes et de l espace en utilisant le
raisonnement et habituellement un systeme special de
symboles et de regles pour les organiser.</rdfs:comment>
<rdfs:label xml:lang="en">mathematics</rdfs:label>
<rdfs:label xml:lang="fr">mathematiques</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MathematicalModellingTopic">
<rdfs:subClassOf rdf:resource="#MathematicsTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">mathematical
modelling</rdfs:label>
<rdfs:label xml:lang="fr">modelisation
mathematique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MarkovianModelsTopic">
<rdfs:subClassOf
rdf:resource="#MathematicalModellingTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">markovian models</rdfs:label>
<rdfs:label xml:lang="fr">modele markovien</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="GeometryTopic">
<rdfs:subClassOf rdf:resource="#MathematicsTopic"/>
<rdfs:comment xml:lang="en">Branch of mathematics relating
to the study of space and the relationships between
points, lines, curves and surfaces.</rdfs:comment>
<rdfs:comment xml:lang="fr">Branche des mathematiques
concernant l etude de l espace et des rapports entre les
points, les lignes, les courbes et les surfaces.
</rdfs:comment>
<rdfs:label xml:lang="en">geometry</rdfs:label>
<rdfs:label xml:lang="fr">geometrie</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="TopologyTopic">
<rdfs:subClassOf rdf:resource="#MathematicsTopic"/>
<rdfs:comment xml:lang="en">Branch of pure mathematics
that deals only with the properties of a figure X that
hold for every figure into which X can be transformed with
a one-to-one correspondence.</rdfs:comment>
<rdfs:comment xml:lang="fr">Branche des mathematiques
pures qui traitent seulement des proprietes d une figure X
qui se retrouvent pour chaque figure en laquelle X peut
etre transformee de facon univoque.</rdfs:comment>
<rdfs:label xml:lang="en">topology</rdfs:label>
<rdfs:label xml:lang="fr">topologie</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="AlgebraTopic">
<rdfs:subClassOf rdf:resource="#MathematicsTopic"/>
<rdfs:comment xml:lang="en">the mathematics of generalized
arithmetical operations.</rdfs:comment>
<rdfs:comment xml:lang="fr">la mathematique des operations
arithmetiques generalisees.</rdfs:comment>
<rdfs:label xml:lang="en">algebra</rdfs:label>
<rdfs:label xml:lang="fr">algebre</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="AnalysisTopic">
<rdfs:subClassOf rdf:resource="#MathematicsTopic"/>
<rdfs:comment xml:lang="en">Branch of mathematics
involving calculus and the theory of limits, sequences,
series, integration and differentiation.</rdfs:comment>
<rdfs:comment xml:lang="fr">Branche des mathematiques
concernant le calcul et la theorie de limites, des suites,
des series, de l integration et de la
derivation.</rdfs:comment>
<rdfs:label xml:lang="en">analysis</rdfs:label>
<rdfs:label xml:lang="fr">analyse</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="NumericalAnalysisTopic">
<rdfs:subClassOf rdf:resource="#AnalysisTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">numerical analysis</rdfs:label>
<rdfs:label xml:lang="fr">analyse numerique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ProbabilitiesTopic">
<rdfs:subClassOf rdf:resource="#MathematicsTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">probabilities</rdfs:label>
<rdfs:label xml:lang="en">probabilistics</rdfs:label>
<rdfs:label xml:lang="fr">probabilites</rdfs:label>
</rdfs:Class>


<rdfs:Class rdf:ID="StatisticsTopic">
<rdfs:subClassOf rdf:resource="#MathematicsTopic"/>
<rdfs:comment xml:lang="en">Branch of applied mathematics
concerned with the collection and interpretation of
quantitative data and the use of probability theory to
estimate population parameters.</rdfs:comment>
<rdfs:comment xml:lang="fr">Branche des mathematiques
appliquees concernee par la collecte et l interpretation
des donnees quantitatives et l utilisation de la theorie
des probabilites pour estimer des parametres de
population.</rdfs:comment>
<rdfs:label xml:lang="en">statistics</rdfs:label>
<rdfs:label xml:lang="fr">statistiques</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="FilteringTopic">
<rdfs:subClassOf rdf:resource="#ProbabilitiesTopic"/>
<rdfs:subClassOf rdf:resource="#StatisticsTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">filtering</rdfs:label>
<rdfs:label xml:lang="fr">filtrage</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="FunctionalEquationsTopic">
<rdfs:subClassOf rdf:resource="#MathematicsTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">functional
equations</rdfs:label>
<rdfs:label xml:lang="fr">equations
fonctionnelles</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="NonlinearSystemsTopic">
<rdfs:subClassOf rdf:resource="#MathematicsTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">non-linear systems</rdfs:label>
<rdfs:label xml:lang="fr">systeme non-
lineaire</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="NonlinearFilteringTopic">
<rdfs:subClassOf rdf:resource="#FilteringTopic"/>
<rdfs:subClassOf rdf:resource="#NonlinearSystemsTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">non-linear
filtering</rdfs:label>
<rdfs:label xml:lang="fr">filtrage non-
lineaire</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="DynamicSystemsTopic">
<rdfs:subClassOf rdf:resource="#MathematicsTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">dynamic systems</rdfs:label>
<rdfs:label xml:lang="fr">systemes dynamiques</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="StochasticDynamicSystemsTopic">
<rdfs:subClassOf rdf:resource="#DynamicSystemsTopic"/>
<rdfs:subClassOf rdf:resource="#StatisticsTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">stochastic dynamic
systems</rdfs:label>
<rdfs:label xml:lang="fr">systemes dynamiques
stochastiques</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="CognitiveSciencesTopic">
<rdfs:subClassOf rdf:resource="#AdditionalTopic"/>
<rdfs:comment xml:lang="en">Topic concerned with the
sciences studying cognition.</rdfs:comment>
<rdfs:comment xml:lang="fr">Sujet concerne par les
sciences etudiant la connaissance.</rdfs:comment>
<rdfs:label xml:lang="en">cognitive sciences</rdfs:label>
<rdfs:label xml:lang="fr">sciences cognitives</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="KnowledgeEngineeringTopic">
<rdfs:subClassOf rdf:resource="#CognitiveSciencesTopic"/>
<rdfs:subClassOf
rdf:resource="#ArtificialIntelligenceTopic"/>
<rdfs:comment xml:lang="en">Field dealing with knowledge
acquisition, representation, validation, inferencing,
explanation and maintenance.</rdfs:comment>
<rdfs:comment xml:lang="fr">Domaine traitant de l
acquisition de la connaissance, sa representation, sa
validation, ses inferences, ses explications et sa
maintenance.</rdfs:comment>
<rdfs:label xml:lang="en">knowledge
engineering</rdfs:label>
<rdfs:label xml:lang="fr">ingenierie de la
connaissance</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="KnowledgeBasedSystemsTopic">
<rdfs:subClassOf
rdf:resource="#KnowledgeEngineeringTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">knowledge based
systems</rdfs:label>
<rdfs:label xml:lang="fr">systemes a base de
connaissance</rdfs:label>
</rdfs:Class>
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<rdfs:Class rdf:ID="KnowledgeManagementTopic">
<rdfs:subClassOf
rdf:resource="#KnowledgeEngineeringTopic"/>
<rdfs:comment xml:lang="en">Field dealing with management
techniques for knowledge capitalization in an
organization.</rdfs:comment>
<rdfs:comment xml:lang="fr">Domaine traitant des
techniques de gestion pour la capitalisation de la
connaissance dans une organisation.</rdfs:comment>
<rdfs:label xml:lang="en">knowledge
management</rdfs:label>
<rdfs:label xml:lang="fr">gestion des
connaissances</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="KnowledgeAcquisitionTopic">
<rdfs:subClassOf
rdf:resource="#KnowledgeEngineeringTopic"/>
<rdfs:comment xml:lang="en">Field dealing with techniques
for acquiring knowledge.</rdfs:comment>
<rdfs:comment xml:lang="fr">Domaine traitant des
techniques pour l acquisition des
connaissances.</rdfs:comment>
<rdfs:label xml:lang="en">knowledge
acquisition</rdfs:label>
<rdfs:label xml:lang="fr">acquisition des
connaissances</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="KnowledgeModelingTopic">
<rdfs:subClassOf
rdf:resource="#KnowledgeEngineeringTopic"/>
<rdfs:comment xml:lang="en">Field dealing with modeling
techniques for representing knowledge.</rdfs:comment>
<rdfs:comment xml:lang="fr">Domaine traitant des
techniques de modelisation pour representer la
connaissance.</rdfs:comment>
<rdfs:label xml:lang="en">knowledge modeling</rdfs:label>
<rdfs:label xml:lang="fr">modelisation des
connaissances</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="OntologyEngineeringTopic">
<rdfs:subClassOf rdf:resource="#KnowledgeModelingTopic"/>
<rdfs:comment xml:lang="en">Field dealing with the
engineering of explicit, partial specification of a
conceptualization.</rdfs:comment>
<rdfs:comment xml:lang="fr">Domaine traitant de l
ingenierie de la specification (explicite mais partielle)
d une conceptualisation.</rdfs:comment>
<rdfs:label xml:lang="en">ontology
engineering</rdfs:label>
<rdfs:label xml:lang="fr">ingenierie
ontologique</rdfs:label>
<rdfs:label xml:lang="fr">ingenierie d
ontologies</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="CorporateMemoryTopic">
<rdfs:subClassOf
rdf:resource="#KnowledgeEngineeringTopic"/>
<rdfs:comment xml:lang="en">An explicit, disembodied and
persistent representation of knowledge and information in
an organization, in order to facilitate their access and
reuse by members of the organization, for their
tasks.</rdfs:comment>
<rdfs:comment xml:lang="fr">Une representation explicite,
desincarnee et persistante des connaissances et des
informations dans une organisation, afin de faciliter leur
acces et leur reutilisation par les membres de l
organisation, pour leurs taches.</rdfs:comment>
<rdfs:label xml:lang="en">corporate memory</rdfs:label>
<rdfs:label xml:lang="fr">memoire d
entreprise</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ComputerScienceTopic">
<rdfs:subClassOf rdf:resource="#AdditionalTopic"/>
<rdfs:comment xml:lang="en">Study of automatic information
and data processing methods, and of computers, including
both hardware and software design.</rdfs:comment>
<rdfs:comment xml:lang="fr">Etude des methodes du
traitement automatique de l information et des donnees,
ainsi que des ordinateurs comprenant l aspect materiel et
logiciel.</rdfs:comment>
<rdfs:label xml:lang="en">computer science</rdfs:label>
<rdfs:label xml:lang="fr">informatique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SoftwareEngineeringTopic">
<rdfs:subClassOf rdf:resource="#ComputerScienceTopic"/>
<rdfs:comment xml:lang="en">The computer science
discipline concerned with developing computer
applications.</rdfs:comment>
<rdfs:comment xml:lang="fr">Discipline informatique
concernee par le developpement d applications
informatiques.</rdfs:comment>
<rdfs:label xml:lang="en">software
engineering</rdfs:label>
<rdfs:label xml:lang="fr">ingenierie
logicielle</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ComputerGraphicsTopic">
<rdfs:subClassOf rdf:resource="#ComputerScienceTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">computer graphics</rdfs:label>
<rdfs:label xml:lang="fr">infographie</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="VirtualRealitySimulationTopic">
<rdfs:subClassOf rdf:resource="#ComputerGraphicsTopic"/>
<rdfs:subClassOf rdf:resource="#SimulationTopic"/>
<rdfs:comment xml:lang="en">A computer simulation of a
real or imaginary system that enables a user to perform
operations on the simulated system and shows the effects
in real time.</rdfs:comment>
<rdfs:comment xml:lang="fr">Une simulation sur ordinateur
d un systeme reel ou imaginaire qui permet a un
utilisateur d agir sur le systeme simule et montre les
effets en temps reel.</rdfs:comment>
<rdfs:label xml:lang="en">virtual reality</rdfs:label>
<rdfs:label xml:lang="fr">realite virtuelles</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ImageProcessingTopic">
<rdfs:subClassOf rdf:resource="#ComputerGraphicsTopic"/>
<rdfs:comment xml:lang="en">Analyzing and manipulating
images with a computer.</rdfs:comment>
<rdfs:comment xml:lang="fr">Analyse et manipulation d
images sur ordinateur.</rdfs:comment>
<rdfs:label xml:lang="en">image processing</rdfs:label>
<rdfs:label xml:lang="fr">traitement d images</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MedicalImagesProcessingTopic">
<rdfs:subClassOf rdf:resource="#ImageProcessingTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">medical images
processing</rdfs:label>
<rdfs:label xml:lang="fr">traitement d images
medicales</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ComputerVisionTopic">
<rdfs:subClassOf rdf:resource="#ImageProcessingTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">computer vision</rdfs:label>
<rdfs:label xml:lang="fr">vision par
ordinateur</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ArtificialIntelligenceTopic">
<rdfs:subClassOf rdf:resource="#ComputerScienceTopic"/>
<rdfs:comment xml:lang="en">Branch of computer science
concerned with making computers behave like
humans.</rdfs:comment>
<rdfs:comment xml:lang="fr">Branche de l informatique
etudiant les methodes informatiques permettant de faire en
sorte qu un ordinateur se comporte comme un
humain.</rdfs:comment>
<rdfs:label xml:lang="en">artificial
intelligence</rdfs:label>
<rdfs:label xml:lang="en">AI</rdfs:label>
<rdfs:label xml:lang="en">A.I.</rdfs:label>
<rdfs:label xml:lang="fr">intelligence
artificielle</rdfs:label>
<rdfs:label xml:lang="fr">IA</rdfs:label>
<rdfs:label xml:lang="fr">I.A.</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ComputerAnalysisTopic">
<rdfs:subClassOf
rdf:resource="#ArtificialIntelligenceTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">computer analysis</rdfs:label>
<rdfs:label xml:lang="fr">analyse par
ordinateur</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="RoboticsTopic">
<rdfs:subClassOf
rdf:resource="#ArtificialIntelligenceTopic"/>
<rdfs:comment xml:lang="en">branch of Artificial
Intelligence concerned with the practical use of
robots.</rdfs:comment>
<rdfs:comment xml:lang="fr">branche de l intelligence
artificielle concernee par l utilisation pratique des
robots.</rdfs:comment>
<rdfs:label xml:lang="en">robotics</rdfs:label>
<rdfs:label xml:lang="fr">robotique</rdfs:label>
</rdfs:Class>

<rdfs:Class
rdf:ID="DistributedArtificialIntelligenceTopic">
<rdfs:subClassOf
rdf:resource="#ArtificialIntelligenceTopic"/>
<rdfs:comment xml:lang="en">Distributed approach of
Artificial Intelligence.</rdfs:comment>
<rdfs:comment xml:lang="fr">Approche distribuee de l
intelligence artificielle.</rdfs:comment>
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<rdfs:label xml:lang="en">distributed artificial
intelligence</rdfs:label>
<rdfs:label xml:lang="en">DAI</rdfs:label>
<rdfs:label xml:lang="en">D.A.I.</rdfs:label>
<rdfs:label xml:lang="fr">intelligence artificielle
distribuee</rdfs:label>
<rdfs:label xml:lang="fr">IAD</rdfs:label>
<rdfs:label xml:lang="fr">I.A.D.</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MultiAgentSystemTopic">
<rdfs:subClassOf
rdf:resource="#DistributedArtificialIntelligenceTopic"/>
<rdfs:comment xml:lang="en">Distributed Artificial
Intelligence where the systems are designed as
organizations of autonomous and loosely coupled pieces of
software.</rdfs:comment>
<rdfs:comment xml:lang="fr">Intelligence artificielle
distribuee ou les systemes sont concus comme des
organisations de composants logiciels autonomes et
faiblement couples.</rdfs:comment>
<rdfs:label xml:lang="en">multi-agents
systems</rdfs:label>
<rdfs:label xml:lang="en">MAS</rdfs:label>
<rdfs:label xml:lang="en">M.A.S.</rdfs:label>
<rdfs:label xml:lang="fr">systemes multi-
agents</rdfs:label>
<rdfs:label xml:lang="fr">SMA</rdfs:label>
<rdfs:label xml:lang="fr">S.M.A.</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SymbolicLearningTopic">
<rdfs:subClassOf
rdf:resource="#ArtificialIntelligenceTopic"/>
<rdfs:comment xml:lang="en">Domain interested in methods
enabling the computers to learn.</rdfs:comment>
<rdfs:comment xml:lang="fr">Domaine s interessant aux
methodes permettant aux ordinateurs d
apprendre.</rdfs:comment>
<rdfs:label xml:lang="en">symbolic learning</rdfs:label>
<rdfs:label xml:lang="en">machine learning</rdfs:label>
<rdfs:label xml:lang="fr">apprentissage
symbolique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="HCITopic">
<rdfs:subClassOf rdf:resource="#ComputerScienceTopic"/>
<rdfs:comment xml:lang="en">Study of human-computer
relations with the aim to improve them.</rdfs:comment>
<rdfs:comment xml:lang="fr">Etude des relations homme-
machine avec pour objectif de les
ameliorer.</rdfs:comment>
<rdfs:label xml:lang="en">HCI</rdfs:label>
<rdfs:label xml:lang="en">H.C.I.</rdfs:label>
<rdfs:label xml:lang="en">human-computer
interaction</rdfs:label>
<rdfs:label xml:lang="fr">IHM</rdfs:label>
<rdfs:label xml:lang="fr">I.H.M.</rdfs:label>
<rdfs:label xml:lang="fr">interactions homme-
machine</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="InteractivityTopic">
<rdfs:subClassOf rdf:resource="#HCITopic"/>
<rdfs:comment xml:lang="en">Study of sensory dialog that
occurs between a human being and a computer
system.</rdfs:comment>
<rdfs:comment xml:lang="fr">Etude du dialogue sensoriel
qui se produit entre un etre d humain et un systeme
informatique.</rdfs:comment>
<rdfs:label xml:lang="en">interactivity</rdfs:label>
<rdfs:label xml:lang="fr">interactivite</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ComputerAlgebraMethodsTopic">
<rdfs:subClassOf rdf:resource="#ProgrammingTopic"/>
<rdfs:subClassOf rdf:resource="#AlgebraTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">computer algebra
methods</rdfs:label>
<rdfs:label xml:lang="fr">methodes d algebre
computationnelle</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SimulationTopic">
<rdfs:subClassOf rdf:resource="#ComputerScienceTopic"/>
<rdfs:subClassOf rdf:resource="#MathematicsTopic"/>
<rdfs:comment xml:lang="en">Science of theoretical account
based on a similarity between the model and the phenomena
that are to be explained.</rdfs:comment>
<rdfs:comment xml:lang="fr">Science etudiant et utilisant
l imitation de processus, phenomenes ou objets pour tenter
de le predire ou de l expliquer.</rdfs:comment>
<rdfs:label xml:lang="en">simulation</rdfs:label>
<rdfs:label xml:lang="fr">simulation</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="DiscreteEventSimulationTopic">
<rdfs:subClassOf rdf:resource="#SimulationTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">discrete event
simulation</rdfs:label>
<rdfs:label xml:lang="fr">simulation d evenements
discrets</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ProgrammingTopic">
<rdfs:subClassOf rdf:resource="#ComputerScienceTopic"/>
<rdfs:comment xml:lang="en">Science of organizing
instructions so that, when executed, they cause the
computer to behave in a predetermined
manner.</rdfs:comment>
<rdfs:comment xml:lang="fr">Science de l organisation d
instructions de sorte que, une fois executees, elles
fassent se comporter l ordinateur de facon
predeterminee.</rdfs:comment>
<rdfs:label xml:lang="en">programming</rdfs:label>
<rdfs:label xml:lang="fr">programmation</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ParallelProgrammingTopic">
<rdfs:subClassOf rdf:resource="#ProgrammingTopic"/>
<rdfs:comment xml:lang="en">A type of programming where
processes occur simultaneously.</rdfs:comment>
<rdfs:comment xml:lang="fr">Un type de programmation ou
les processus se produisent simultanement.</rdfs:comment>
<rdfs:label xml:lang="en">parallel
programming</rdfs:label>
<rdfs:label xml:lang="fr">programmation
parallele</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ObjectProgrammingTopic">
<rdfs:subClassOf rdf:resource="#ProgrammingTopic"/>
<rdfs:comment xml:lang="en">A type of programming in which
programmers define not only the data type of a data
structure, but also the types of operations -functions-
that can be applied to the data structure.</rdfs:comment>
<rdfs:comment xml:lang="fr">Un type de programmation dans
lequel les programmeurs definissent non seulement le type
des structures de donnees, mais egalement les types d
operations - fonctions, methodes - qui peuvent etre
appliquees a ces structures de donnees.</rdfs:comment>
<rdfs:label xml:lang="en">object-programming</rdfs:label>
<rdfs:label xml:lang="fr">programmation objet</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ParallelObjectProgrammingTopic">
<rdfs:subClassOf
rdf:resource="#ParallelProgrammingTopic"/>
<rdfs:subClassOf rdf:resource="#ObjectProgrammingTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">parallel- object-
programming</rdfs:label>
<rdfs:label xml:lang="fr">programmation objet
parallele</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="JavaProgrammingTopic">
<rdfs:subClassOf rdf:resource="#ObjectProgrammingTopic"/>
<rdfs:comment xml:lang="en">Progamming in JAVA object-
oriented language.</rdfs:comment>
<rdfs:comment xml:lang="fr">Programmation en langage JAVA
oriente objet.</rdfs:comment>
<rdfs:label xml:lang="en">java programming</rdfs:label>
<rdfs:label xml:lang="fr">programmation java</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="TelecommunicationsTopic">
<rdfs:subClassOf rdf:resource="#AdditionalTopic"/>
<rdfs:comment xml:lang="en">Domain concerned with the
technology of electronic communication at a
distance.</rdfs:comment>
<rdfs:comment xml:lang="fr">Domaine concerne par la
technologie de transmission electronique a
distance.</rdfs:comment>
<rdfs:label xml:lang="en">telecommunications</rdfs:label>
<rdfs:label xml:lang="fr">telecommunications</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MobilePhoneTopic">
<rdfs:subClassOf rdf:resource="#TelecommunicationsTopic"/>
<rdfs:comment xml:lang="en">Telecommunications part
concerned with portable radiotelephones.</rdfs:comment>
<rdfs:comment xml:lang="fr">Branche des telecommunications
concernee par les radiotelephones
portables.</rdfs:comment>
<rdfs:label xml:lang="en">mobile phones</rdfs:label>
<rdfs:label xml:lang="en">cellular phones</rdfs:label>
<rdfs:label xml:lang="fr">telephones
portables</rdfs:label>
<rdfs:label xml:lang="fr">telephones
cellulaires</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="WMLTopic">
<rdfs:subClassOf rdf:resource="#NetworkTopic"/>
<rdfs:subClassOf rdf:resource="#MobilePhoneTopic"/>
<rdfs:comment xml:lang="en">Wireless Markup Language is an
XML language used to specify content and user interface
for WAP devices.</rdfs:comment>
```

```
<rdfs:comment xml:lang="fr">Langage de marqueurs pour les
telephones portables en XML utilise pour specifier le
contenu et les interfaces utilisteurs pour les terminaux
WAP.</rdfs:comment>
<rdfs:label xml:lang="en">wml</rdfs:label>
<rdfs:label xml:lang="en">W.M.L.</rdfs:label>
<rdfs:label xml:lang="en">wireless markup
language</rdfs:label>
<rdfs:label xml:lang="fr">wml</rdfs:label>
<rdfs:label xml:lang="fr">W.M.L.</rdfs:label>
<rdfs:label xml:lang="fr">langage de marqueurs pour les
telephones portables</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MobilePhoneTechnologyTopic">
<rdfs:subClassOf rdf:resource="#MobilePhoneTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">mobile phone
technology</rdfs:label>
<rdfs:label xml:lang="fr">technologie de la telephonie
sans fil</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MobilePhoneArchitectureTopic">
<rdfs:subClassOf rdf:resource="#MobilePhoneTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">mobile phone
architecture</rdfs:label>
<rdfs:label xml:lang="fr">architecture des telephones sans
fil</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MobilePhonePlanningSystemTopic">
<rdfs:subClassOf rdf:resource="#MobilePhoneTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">mobile phone planning
system</rdfs:label>
<rdfs:label xml:lang="fr">systeme de planification des
telephones sans fil</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MobilePhoneFrequencyPlanningTopic">
<rdfs:subClassOf rdf:resource="#MobilePhoneTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">mobile phone frequency
planning</rdfs:label>
<rdfs:label xml:lang="fr">planification des frequences des
telephones sans fil</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MobilePhoneServiceTopic">
<rdfs:subClassOf rdf:resource="#MobilePhoneTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">mobile phone
service</rdfs:label>
<rdfs:label xml:lang="fr">service de telephones
portables</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MobilePhoneProtocolsTopic">
<rdfs:subClassOf rdf:resource="#MobilePhoneTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">mobile phone
protocols</rdfs:label>
<rdfs:label xml:lang="fr">protocole de telephones
portables</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="WapTopic">
<rdfs:subClassOf
rdf:resource="#MobilePhoneProtocolsTopic"/>
<rdfs:comment xml:lang="en">Wireless Application Protocol
is a secure specification that allows users to access
information instantly via handheld wireless devices such
as mobile phones, pagers, two-way radios, smartphones and
communicators.</rdfs:comment>
<rdfs:comment xml:lang="fr">Protocole d application sans
fil, specification securisee qui permet a des utilisateurs
d acceder a l information immediatement par l
intermediaire des dispositifs sans fil tels que les
telephones portables, les pagers, les radios bi-
directionnelles...</rdfs:comment>
<rdfs:label xml:lang="en">wap</rdfs:label>
<rdfs:label xml:lang="en">WAP</rdfs:label>
<rdfs:label xml:lang="en">W.A.P</rdfs:label>
<rdfs:label xml:lang="en">wireless application
protocol</rdfs:label>
<rdfs:label xml:lang="fr">wap</rdfs:label>
<rdfs:label xml:lang="fr">WAP</rdfs:label>
<rdfs:label xml:lang="fr">W.A.P</rdfs:label>
<rdfs:label xml:lang="fr">protocole d application pour les
sans fils</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="GPRSTopic">
<rdfs:subClassOf
rdf:resource="#MobilePhoneProtocolsTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">GPRS</rdfs:label>
<rdfs:label xml:lang="en">G.P.R.S.</rdfs:label>
<rdfs:label xml:lang="en">general packet radio
service</rdfs:label>
<rdfs:label xml:lang="fr">GPRS</rdfs:label>
<rdfs:label xml:lang="fr">G.P.R.S.</rdfs:label>
<rdfs:label xml:lang="fr">service general de radio par
paquets</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="GSMTopic">
<rdfs:subClassOf
rdf:resource="#MobilePhoneProtocolsTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">GSM</rdfs:label>
<rdfs:label xml:lang="en">G.S.M.</rdfs:label>
<rdfs:label xml:lang="en">global system for mobile
communications</rdfs:label>
<rdfs:label xml:lang="fr">GSM</rdfs:label>
<rdfs:label xml:lang="fr">G.S.M.</rdfs:label>
<rdfs:label xml:lang="fr">systeme mondial pour les
transmissions mobiles</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="UMTSTopic">
<rdfs:subClassOf
rdf:resource="#MobilePhoneProtocolsTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">UMTS</rdfs:label>
<rdfs:label xml:lang="en">U.M.T.S.</rdfs:label>
<rdfs:label xml:lang="en">universal mobile
telecommunications system</rdfs:label>
<rdfs:label xml:lang="fr">UMTS</rdfs:label>
<rdfs:label xml:lang="fr">U.M.T.S.</rdfs:label>
<rdfs:label xml:lang="fr">systeme universel de
télécommunications mobiles</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MobileIPTopic">
<rdfs:subClassOf rdf:resource="#MobilePhoneTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">mobile IP</rdfs:label>
<rdfs:label xml:lang="en">mobile internet
protocol</rdfs:label>
<rdfs:label xml:lang="fr">IP mobile</rdfs:label>
<rdfs:label xml:lang="fr">protocole internet
mobile</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MobilePhoneTerminalsTopic">
<rdfs:subClassOf rdf:resource="#MobilePhoneTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">mobile phone
terminals</rdfs:label>
<rdfs:label xml:lang="fr">terminaux de telephonie
mobile</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PDATopic">
<rdfs:subClassOf
rdf:resource="#MobilePhoneTerminalsTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">PDA</rdfs:label>
<rdfs:label xml:lang="en">P.D.A.</rdfs:label>
<rdfs:label xml:lang="en">personal digital
assistant</rdfs:label>
<rdfs:label xml:lang="fr">PDA</rdfs:label>
<rdfs:label xml:lang="fr">P.D.A.</rdfs:label>
<rdfs:label xml:lang="fr">assistants electroniques
personnels</rdfs:label>
</rdfs:Class>


<rdfs:Class rdf:ID="MobilePhoneSateliteServiceTopic">
<rdfs:subClassOf rdf:resource="#MobilePhoneTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">mobile phone satelite
service</rdfs:label>
<rdfs:label xml:lang="fr">service satelite pour les
telephones portables</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="NetworkTopic">
<rdfs:subClassOf rdf:resource="#TelecommunicationsTopic"/>
<rdfs:subClassOf rdf:resource="#ComputerScienceTopic"/>
<rdfs:comment xml:lang="en">A group of two or more
computer systems linked together.</rdfs:comment>
<rdfs:comment xml:lang="fr">Un groupe de deux systemes
informatiques ou plus relies ensemble.</rdfs:comment>
<rdfs:label xml:lang="en">network</rdfs:label>
<rdfs:label xml:lang="fr">reseau</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="CORBATopic">
<rdfs:subClassOf rdf:resource="#NetworkTopic"/>
```

```
<rdfs:subClassOf rdf:resource="#ObjectProgrammingTopic"/>
<rdfs:comment xml:lang="en">Common Object Request Broker
Architecture, an architecture that enables pieces of
programs, called objects, to communicate with one another
regardless of what programming language they were written
in or what operating system they are running
on.</rdfs:comment>
<rdfs:comment xml:lang="fr">Architecture commune de
mediation de requetes entre objets qui permet a des
elements de programmes, appeles objets, de communiquer
entre eux independamment du langage de programmation dans
lequel ils ont ete ecrits ou du systeme d exploitation sur
lequel ils s executent. </rdfs:comment>
<rdfs:label xml:lang="en">CORBA</rdfs:label>
<rdfs:label xml:lang="en">C.O.R.B.A.</rdfs:label>
<rdfs:label xml:lang="en">common object request broker
architecture</rdfs:label>
<rdfs:label xml:lang="fr">CORBA</rdfs:label>
<rdfs:label xml:lang="fr">C.O.R.B.A.</rdfs:label>
<rdfs:label xml:lang="fr">architecture commune de
mediation de requetes entre objets</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="RMITopic">
<rdfs:subClassOf rdf:resource="#NetworkTopic"/>
<rdfs:subClassOf rdf:resource="#ObjectProgrammingTopic"/>
<rdfs:comment xml:lang="en">Remote Method Invocation, a
set of protocols being developed by Sun s JavaSoft
division that enables Java objects to communicate remotely
with other Java objects.</rdfs:comment>
<rdfs:comment xml:lang="fr">Invocation  de methode a
distance, basee sur un ensemble de protocoles developpe
par la division JavaSoft de Sun qui permet a des objets
Java de communiquer a distance avec d autres objets
Java.</rdfs:comment>
<rdfs:label xml:lang="en">RMI</rdfs:label>
<rdfs:label xml:lang="en">R.M.I.</rdfs:label>
<rdfs:label xml:lang="en">remote method
invocation</rdfs:label>
<rdfs:label xml:lang="fr">RMI</rdfs:label>
<rdfs:label xml:lang="fr">R.M.I.</rdfs:label>
<rdfs:label xml:lang="fr">remote method
invocation</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="InternetTopic">
<rdfs:subClassOf rdf:resource="#NetworkTopic"/>
<rdfs:comment xml:lang="en">A global network connecting
millions of computers.</rdfs:comment>
<rdfs:comment xml:lang="fr">Un reseau mondial reliant des
millions d ordinateurs.</rdfs:comment>
<rdfs:label xml:lang="en">Internet</rdfs:label>
<rdfs:label xml:lang="fr">Internet</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="TCPIPTopic">
<rdfs:subClassOf rdf:resource="#InternetTopic"/>
<rdfs:comment xml:lang="en">Transmission Control
Protocol/Internet Protocol, the suite of communications
protocols used to connect hosts on the
Internet.</rdfs:comment>
<rdfs:comment xml:lang="fr">Protocole de controle de
transmission/Protocole Internet, la suite des protocoles
de transmissions utilisee pour connecter des ordinateurs
sur Internet</rdfs:comment>
<rdfs:label xml:lang="en">TCP-IP</rdfs:label>
<rdfs:label xml:lang="en">TCP/IP</rdfs:label>
<rdfs:label xml:lang="fr">TCP-IP</rdfs:label>
<rdfs:label xml:lang="fr">TCP/IP</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="WebTopic">
<rdfs:subClassOf rdf:resource="#NetworkTopic"/>
<rdfs:comment xml:lang="en">Internet servers networks that
support specially formatted documents.</rdfs:comment>
<rdfs:comment xml:lang="fr">Reseaux de serveurs Internet
qui supportent les documents specialement
formates.</rdfs:comment>
<rdfs:label xml:lang="en">Web</rdfs:label>
<rdfs:label xml:lang="fr">Web</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="HTTPTopic">
<rdfs:subClassOf rdf:resource="#WebTopic"/>
<rdfs:comment xml:lang="en">Web protocol for transferring
hypertext.</rdfs:comment>
<rdfs:comment xml:lang="fr">Protocole Web pour le
transfert d hypertexte.</rdfs:comment>
<rdfs:label xml:lang="en">HTTP</rdfs:label>
<rdfs:label xml:lang="en">H.T.T.P.</rdfs:label>
<rdfs:label xml:lang="en">hypertext transfer
protocol</rdfs:label>
<rdfs:label xml:lang="fr">HTTP</rdfs:label>
<rdfs:label xml:lang="fr">H.T.T.P.</rdfs:label>
<rdfs:label xml:lang="fr">protocole de transfert d
hypertexte</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="HTMLTopic">
<rdfs:subClassOf rdf:resource="#WebTopic"/>
<rdfs:comment xml:lang="en">Web language for hypertext
markups.</rdfs:comment>
<rdfs:comment xml:lang="fr">Langage de marqueurs/balises d
hypertextes pour le Web.</rdfs:comment>
<rdfs:label xml:lang="en">HTML</rdfs:label>
<rdfs:label xml:lang="en">H.T.M.L.</rdfs:label>
<rdfs:label xml:lang="en">hypertext markup
language</rdfs:label>
<rdfs:label xml:lang="fr">HTML</rdfs:label>
<rdfs:label xml:lang="fr">H.T.M.L.</rdfs:label>
<rdfs:label xml:lang="fr">langage de marqueurs d
hypertextes</rdfs:label>
<rdfs:label xml:lang="fr">langage de balises d
hypertextes</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="XMLTopic">
<rdfs:subClassOf rdf:resource="#WebTopic"/>
<rdfs:comment xml:lang="en">Web Extensible Markup Language
enabling the definition, transmission, validation, and
interpretation of data between applications and between
organizations.</rdfs:comment>
<rdfs:comment xml:lang="fr">Langage de marqueurs
extensible pour le Web permettant la definition, la
transmission, la validation, et la traduction des donnees
entre les applications et entre les
organisations.</rdfs:comment>
<rdfs:label xml:lang="en">XML</rdfs:label>
<rdfs:label xml:lang="en">X.M.L.</rdfs:label>
<rdfs:label xml:lang="en">extensible markup
language</rdfs:label>
<rdfs:label xml:lang="fr">XML</rdfs:label>
<rdfs:label xml:lang="fr">X.M.L.</rdfs:label>
<rdfs:label xml:lang="fr">langage de marqueurs
extensible</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="RDFTopic">
<rdfs:subClassOf rdf:resource="#XMLTopic"/>
<rdfs:comment xml:lang="en">Web Resource Description
Framework.</rdfs:comment>
<rdfs:comment xml:lang="fr">Formalisme de description de
ressources Web.</rdfs:comment>
<rdfs:label xml:lang="en">RDF</rdfs:label>
<rdfs:label xml:lang="en">R.D.F.</rdfs:label>
<rdfs:label xml:lang="en">resource description
framework</rdfs:label>
<rdfs:label xml:lang="fr">RDF</rdfs:label>
<rdfs:label xml:lang="fr">R.D.F.</rdfs:label>
<rdfs:label xml:lang="fr">formalisme de description de
ressources</rdfs:label>
</rdfs:Class>


<!-- Additional Topics defined for CSTB view -->

<rdfs:Class rdf:ID="BuildingTopic">
<rdfs:subClassOf rdf:resource="#AdditionalTopic"/>
<rdfs:comment xml:lang="en"/>
<rdfs:comment xml:lang="fr"/>
<rdfs:label xml:lang="en">building</rdfs:label>
<rdfs:label xml:lang="fr">batiment</rdfs:label>
<rdfs:label xml:lang="fr">construction</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ScienceAppliedToBuildingTopic">
<rdfs:subClassOf rdf:resource="#BuildingTopic"/>
<rdfs:comment xml:lang="en">10</rdfs:comment>
<rdfs:comment xml:lang="fr">10</rdfs:comment>
<rdfs:label xml:lang="en">sciences applied to
building</rdfs:label>
<rdfs:label xml:lang="fr">sciences appliquees au
batiment</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="TestBuildingTopic">
<rdfs:subClassOf
rdf:resource="#ScienceAppliedToBuildingTopic"/>
<rdfs:comment xml:lang="en">11</rdfs:comment>
<rdfs:comment xml:lang="fr">11</rdfs:comment>
<rdfs:label xml:lang="en">test</rdfs:label>
<rdfs:label xml:lang="fr">essai</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MeasurementBuildingTopic">
<rdfs:subClassOf
rdf:resource="#ScienceAppliedToBuildingTopic"/>
<rdfs:comment xml:lang="en">11</rdfs:comment>
<rdfs:comment xml:lang="fr">11</rdfs:comment>
<rdfs:label xml:lang="en">measurement</rdfs:label>
<rdfs:label xml:lang="fr">mesure</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MetrologyBuildingTopic">
<rdfs:subClassOf
rdf:resource="#ScienceAppliedToBuildingTopic"/>
<rdfs:comment xml:lang="en">11</rdfs:comment>
<rdfs:comment xml:lang="fr">11</rdfs:comment>
<rdfs:label xml:lang="en">metrology</rdfs:label>
<rdfs:label xml:lang="fr">metrologie</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="AcousticsBuildingTopic">
<rdfs:subClassOf
rdf:resource="#ScienceAppliedToBuildingTopic"/>
```

```
<rdfs:comment xml:lang="en">12</rdfs:comment>
<rdfs:comment xml:lang="fr">12</rdfs:comment>
<rdfs:label xml:lang="en">acoustics</rdfs:label>
<rdfs:label xml:lang="fr">acoustique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="AerodynamicsBuildingTopic">
<rdfs:subClassOf
rdf:resource="#ScienceAppliedToBuildingTopic"/>
<rdfs:comment xml:lang="en">13</rdfs:comment>
<rdfs:comment xml:lang="fr">13</rdfs:comment>
<rdfs:label xml:lang="en">aerodynamics</rdfs:label>
<rdfs:label xml:lang="fr">aerodynamique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MechanicalResistanceBuildingTopic">
<rdfs:subClassOf
rdf:resource="#ScienceAppliedToBuildingTopic"/>
<rdfs:comment xml:lang="en">14</rdfs:comment>
<rdfs:comment xml:lang="fr">14</rdfs:comment>
<rdfs:label xml:lang="en">mechanical
resistance</rdfs:label>
<rdfs:label xml:lang="fr">resistance mecanique
</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="StabilityBuildingTopic">
<rdfs:subClassOf
rdf:resource="#ScienceAppliedToBuildingTopic"/>
<rdfs:comment xml:lang="en">14</rdfs:comment>
<rdfs:comment xml:lang="fr">14</rdfs:comment>
<rdfs:label xml:lang="en">stability</rdfs:label>
<rdfs:label xml:lang="fr">stabilite</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ThermicsBuildingTopic">
<rdfs:subClassOf
rdf:resource="#ScienceAppliedToBuildingTopic"/>
<rdfs:comment xml:lang="en">15</rdfs:comment>
<rdfs:comment xml:lang="fr">15</rdfs:comment>
<rdfs:label xml:lang="en">thermics</rdfs:label>
<rdfs:label xml:lang="fr">thermique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="HygrothermicsBuildingTopic">
<rdfs:subClassOf
rdf:resource="#ScienceAppliedToBuildingTopic"/>
<rdfs:comment xml:lang="en">15</rdfs:comment>
<rdfs:comment xml:lang="fr">15</rdfs:comment>
<rdfs:label xml:lang="en">hygrothermics</rdfs:label>
<rdfs:label xml:lang="fr">hygrothermique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="LightingBuildingTopic">
<rdfs:subClassOf
rdf:resource="#ScienceAppliedToBuildingTopic"/>
<rdfs:comment xml:lang="en">15</rdfs:comment>
<rdfs:comment xml:lang="fr">15</rdfs:comment>
<rdfs:label xml:lang="en">lighting</rdfs:label>
<rdfs:label xml:lang="fr">eclairage</rdfs:label>
</rdfs:Class>

<rdfs:Class
rdf:ID="WaterAnalyzeAndTreatmentBuildingTopic">
<rdfs:subClassOf
rdf:resource="#ScienceAppliedToBuildingTopic"/>
<rdfs:comment xml:lang="en">16</rdfs:comment>
<rdfs:comment xml:lang="fr">16</rdfs:comment>
<rdfs:label xml:lang="en">water analyze and
treatment</rdfs:label>
<rdfs:label xml:lang="fr">analyse et traitement de l
eau</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SoilMechanicsBuildingTopic">
<rdfs:subClassOf
rdf:resource="#ScienceAppliedToBuildingTopic"/>
<rdfs:comment xml:lang="en">17</rdfs:comment>
<rdfs:comment xml:lang="fr">17</rdfs:comment>
<rdfs:label xml:lang="en">soil mechanics</rdfs:label>
<rdfs:label xml:lang="fr">mechanique des sols</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="CivilEngineeringBuildingTopic">
<rdfs:subClassOf
rdf:resource="#ScienceAppliedToBuildingTopic"/>
<rdfs:comment xml:lang="en">17</rdfs:comment>
<rdfs:comment xml:lang="fr">17</rdfs:comment>
<rdfs:label xml:lang="en">civil engineering</rdfs:label>
<rdfs:label xml:lang="fr">genie civil</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ClimatologyBuildingTopic">
<rdfs:subClassOf
rdf:resource="#ScienceAppliedToBuildingTopic"/>
<rdfs:comment xml:lang="en">18</rdfs:comment>
<rdfs:comment xml:lang="fr">18</rdfs:comment>
<rdfs:label xml:lang="en">climatology</rdfs:label>
<rdfs:label xml:lang="fr">climatologie</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="EnergyBuildingTopic">
<rdfs:subClassOf
rdf:resource="#ScienceAppliedToBuildingTopic"/>
<rdfs:comment xml:lang="en">19</rdfs:comment>
<rdfs:comment xml:lang="fr">19</rdfs:comment>
<rdfs:label xml:lang="en">energy</rdfs:label>
<rdfs:label xml:lang="fr">energie</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MaterialAndWorkTechnicsTopic">
<rdfs:subClassOf rdf:resource="#BuildingTopic"/>
<rdfs:comment xml:lang="en">20</rdfs:comment>
<rdfs:comment xml:lang="fr">20</rdfs:comment>
<rdfs:label xml:lang="en">material and work
technics</rdfs:label>
<rdfs:label xml:lang="fr">technique des ouvrages et
materiaux</rdfs:label>
<rdfs:label xml:lang="fr">technologie des ouvrages et
materiaux</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ShellTopic">
<rdfs:subClassOf
rdf:resource="#MaterialAndWorkTechnicsTopic"/>
<rdfs:comment xml:lang="en">22</rdfs:comment>
<rdfs:comment xml:lang="fr">22</rdfs:comment>
<rdfs:label xml:lang="en">shell</rdfs:label>
<rdfs:label xml:lang="fr">gros oeuvre</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="StructureTopic">
<rdfs:subClassOf rdf:resource="#ShellTopic"/>
<rdfs:comment xml:lang="en">221</rdfs:comment>
<rdfs:comment xml:lang="fr">221</rdfs:comment>
<rdfs:label xml:lang="en">structure</rdfs:label>
<rdfs:label xml:lang="fr">structure</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="OuterLayerTopic">
<rdfs:subClassOf rdf:resource="#ShellTopic"/>
<rdfs:comment xml:lang="en">222</rdfs:comment>
<rdfs:comment xml:lang="fr">222</rdfs:comment>
<rdfs:label xml:lang="en">outer layer</rdfs:label>
<rdfs:label xml:lang="en">casing</rdfs:label>
<rdfs:label xml:lang="en">enveloppe</rdfs:label>
<rdfs:label xml:lang="fr">enveloppe</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="RoofTopic">
<rdfs:subClassOf rdf:resource="#ShellTopic"/>
<rdfs:comment xml:lang="en">223</rdfs:comment>
<rdfs:comment xml:lang="fr">223</rdfs:comment>
<rdfs:label xml:lang="en">roof</rdfs:label>
<rdfs:label xml:lang="fr">toiture</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="FacadeBuildingTopic">
<rdfs:subClassOf rdf:resource="#ShellTopic"/>
<rdfs:comment xml:lang="en">224</rdfs:comment>
<rdfs:comment xml:lang="fr">224</rdfs:comment>
<rdfs:label xml:lang="en">front</rdfs:label>
<rdfs:label xml:lang="en">facade</rdfs:label>
<rdfs:label xml:lang="fr">facade</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="FoundationsTopic">
<rdfs:subClassOf rdf:resource="#ShellTopic"/>
<rdfs:comment xml:lang="en">225</rdfs:comment>
<rdfs:comment xml:lang="fr">225</rdfs:comment>
<rdfs:label xml:lang="en">foundations</rdfs:label>
<rdfs:label xml:lang="fr">fondations</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="OutsideDevelopmentTopic">
<rdfs:subClassOf
rdf:resource="#MaterialAndWorkTechnicsTopic"/>
<rdfs:comment xml:lang="en">21</rdfs:comment>
<rdfs:comment xml:lang="fr">21</rdfs:comment>
<rdfs:label xml:lang="en">outside development</rdfs:label>
<rdfs:label xml:lang="fr">amenagements
exterieurs</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="RoadTopic">
<rdfs:subClassOf rdf:resource="#OutsideDevelopmentTopic"/>
<rdfs:comment xml:lang="en">21</rdfs:comment>
<rdfs:comment xml:lang="fr">21</rdfs:comment>
<rdfs:label xml:lang="en">road</rdfs:label>
<rdfs:label xml:lang="fr">voirie</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="DrainageTopic">
<rdfs:subClassOf rdf:resource="#OutsideDevelopmentTopic"/>
<rdfs:comment xml:lang="en">21</rdfs:comment>
<rdfs:comment xml:lang="fr">21</rdfs:comment>
<rdfs:label xml:lang="en">drainage</rdfs:label>
<rdfs:label xml:lang="fr">drainage</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SecondWorkTopic">
<rdfs:subClassOf
rdf:resource="#MaterialAndWorkTechnicsTopic"/>
<rdfs:comment xml:lang="en">23</rdfs:comment>
<rdfs:comment xml:lang="fr">23</rdfs:comment>
```

```
<rdfs:label xml:lang="en">second work</rdfs:label>
<rdfs:label xml:lang="fr">second oeuvre</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="JoineryTopic">
<rdfs:subClassOf rdf:resource="#SecondWorkTopic"/>
<rdfs:comment xml:lang="en">231</rdfs:comment>
<rdfs:comment xml:lang="fr">231</rdfs:comment>
<rdfs:label xml:lang="en">joinery</rdfs:label>
<rdfs:label xml:lang="en">carpentry</rdfs:label>
<rdfs:label xml:lang="fr">menuiserie</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="DoorTopic">
<rdfs:subClassOf rdf:resource="#JoineryTopic"/>
<rdfs:comment xml:lang="en">231</rdfs:comment>
<rdfs:comment xml:lang="fr">231</rdfs:comment>
<rdfs:label xml:lang="en">door</rdfs:label>
<rdfs:label xml:lang="fr">porte</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="WindowTopic">
<rdfs:subClassOf rdf:resource="#JoineryTopic"/>
<rdfs:comment xml:lang="en">231</rdfs:comment>
<rdfs:comment xml:lang="fr">231</rdfs:comment>
<rdfs:label xml:lang="en">window</rdfs:label>
<rdfs:label xml:lang="fr">fenetre</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ShutterTopic">
<rdfs:subClassOf rdf:resource="#JoineryTopic"/>
<rdfs:comment xml:lang="en">231</rdfs:comment>
<rdfs:comment xml:lang="fr">231</rdfs:comment>
<rdfs:label xml:lang="en">shutter</rdfs:label>
<rdfs:label xml:lang="fr">volets</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="InsulationTopic">
<rdfs:subClassOf rdf:resource="#SecondWorkTopic"/>
<rdfs:comment xml:lang="en">232</rdfs:comment>
<rdfs:comment xml:lang="fr">232</rdfs:comment>
<rdfs:label xml:lang="en">insulation</rdfs:label>
<rdfs:label xml:lang="fr">isolation</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SoundInsulationTopic">
<rdfs:subClassOf rdf:resource="#InsulationTopic"/>
<rdfs:comment xml:lang="en">232</rdfs:comment>
<rdfs:comment xml:lang="fr">232</rdfs:comment>
<rdfs:label xml:lang="en">sound insulation</rdfs:label>
<rdfs:label xml:lang="en">sound proofing</rdfs:label>
<rdfs:label xml:lang="fr">isolation phonique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ThermalInsulationTopic">
<rdfs:subClassOf rdf:resource="#InsulationTopic"/>
<rdfs:comment xml:lang="en">232</rdfs:comment>
<rdfs:comment xml:lang="fr">232</rdfs:comment>
<rdfs:label xml:lang="en">thermal insulation</rdfs:label>
<rdfs:label xml:lang="fr">isolation thermique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="CoatingWorkTopic">
<rdfs:subClassOf rdf:resource="#SecondWorkTopic"/>
<rdfs:comment xml:lang="en">233</rdfs:comment>
<rdfs:comment xml:lang="fr">233</rdfs:comment>
<rdfs:label xml:lang="en">coating</rdfs:label>
<rdfs:label xml:lang="fr">revetement</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="FacingTopic">
<rdfs:subClassOf rdf:resource="#CoatingWorkTopic"/>
<rdfs:comment xml:lang="en">233</rdfs:comment>
<rdfs:comment xml:lang="fr">233</rdfs:comment>
<rdfs:label xml:lang="en">facing</rdfs:label>
<rdfs:label xml:lang="en">wall coating</rdfs:label>
<rdfs:label xml:lang="fr">revetement mur</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="FlooringTopic">
<rdfs:subClassOf rdf:resource="#CoatingWorkTopic"/>
<rdfs:comment xml:lang="en">233</rdfs:comment>
<rdfs:comment xml:lang="fr">233</rdfs:comment>
<rdfs:label xml:lang="en">flooring</rdfs:label>
<rdfs:label xml:lang="en">floor coating</rdfs:label>
<rdfs:label xml:lang="fr">revetement sol</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PartitionTopic">
<rdfs:subClassOf rdf:resource="#SecondWorkTopic"/>
<rdfs:comment xml:lang="en">234</rdfs:comment>
<rdfs:comment xml:lang="fr">234</rdfs:comment>
<rdfs:label xml:lang="en">partition</rdfs:label>
<rdfs:label xml:lang="fr">cloison</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PipeAndShaftTopic">
<rdfs:subClassOf rdf:resource="#SecondWorkTopic"/>
<rdfs:comment xml:lang="en">235</rdfs:comment>
<rdfs:comment xml:lang="fr">235</rdfs:comment>
<rdfs:label xml:lang="en">pipe and shaft</rdfs:label>
<rdfs:label xml:lang="en">conduit</rdfs:label>
<rdfs:label xml:lang="en">outer covering</rdfs:label>
<rdfs:label xml:lang="fr">conduit et gaine</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="VentilationShaftTopic">
<rdfs:subClassOf rdf:resource="#PipeAndShaftTopic"/>
<rdfs:comment xml:lang="en">235</rdfs:comment>
<rdfs:comment xml:lang="fr">235</rdfs:comment>
<rdfs:label xml:lang="en">ventilation shaft</rdfs:label>
<rdfs:label xml:lang="fr">gaine de
ventilation</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="AirPipeTopic">
<rdfs:subClassOf rdf:resource="#PipeAndShaftTopic"/>
<rdfs:comment xml:lang="en">235</rdfs:comment>
<rdfs:comment xml:lang="fr">235</rdfs:comment>
<rdfs:label xml:lang="en">air pipe</rdfs:label>
<rdfs:label xml:lang="fr">conduit d air</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="EquipmentTopic">
<rdfs:subClassOf
rdf:resource="#MaterialAndWorkTechnicsTopic"/>
<rdfs:comment xml:lang="en">24</rdfs:comment>
<rdfs:comment xml:lang="fr">24</rdfs:comment>
<rdfs:label xml:lang="en">equipment</rdfs:label>
<rdfs:label xml:lang="en">facilities</rdfs:label>
<rdfs:label xml:lang="en">installations</rdfs:label>
<rdfs:label xml:lang="fr">equipement</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="EnergeticEngineeringTopic">
<rdfs:subClassOf rdf:resource="#EquipmentTopic"/>
<rdfs:comment xml:lang="en">241</rdfs:comment>
<rdfs:comment xml:lang="fr">241</rdfs:comment>
<rdfs:label xml:lang="en">energetic
engineering</rdfs:label>
<rdfs:label xml:lang="fr">genie energetique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SanitaryEquipmentTopic">
<rdfs:subClassOf rdf:resource="#EquipmentTopic"/>
<rdfs:comment xml:lang="en">242</rdfs:comment>
<rdfs:comment xml:lang="fr">242</rdfs:comment>
<rdfs:label xml:lang="en">sanitary equipment</rdfs:label>
<rdfs:label xml:lang="fr">equipements
sanitaires</rdfs:label> </rdfs:Class>

<rdfs:Class rdf:ID="LightingTopic">
<rdfs:subClassOf rdf:resource="#EquipmentTopic"/>
<rdfs:comment xml:lang="en">243</rdfs:comment>
<rdfs:comment xml:lang="fr">243</rdfs:comment>
<rdfs:label xml:lang="en">lighting</rdfs:label>
<rdfs:label xml:lang="fr">eclairage</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="HomeAutomationTopic">
<rdfs:subClassOf rdf:resource="#EquipmentTopic"/>
<rdfs:comment xml:lang="en">244</rdfs:comment>
<rdfs:comment xml:lang="fr">244</rdfs:comment>
<rdfs:label xml:lang="en">house automation</rdfs:label>
<rdfs:label xml:lang="fr">domotique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="BuildingMaterialTopic">
<rdfs:subClassOf
rdf:resource="#MaterialAndWorkTechnicsTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">building materials</rdfs:label>
<rdfs:label xml:lang="fr">materiaux de
construction</rdfs:label>
<rdfs:label xml:lang="fr">produits de
construction</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ConcreteTopic">
<rdfs:subClassOf rdf:resource="#BuildingMaterialTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">concrete</rdfs:label>
<rdfs:label xml:lang="fr">beton</rdfs:label> </rdfs:Class>

<rdfs:Class rdf:ID="RubberTopic">
<rdfs:subClassOf rdf:resource="#BuildingMaterialTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">rubber</rdfs:label>
<rdfs:label xml:lang="fr">caoutchouc</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="CoatingTopic">
<rdfs:subClassOf rdf:resource="#BuildingMaterialTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">coating</rdfs:label>
<rdfs:label xml:lang="fr">enduit</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PlasterTopic">
<rdfs:subClassOf rdf:resource="#CoatingTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
```

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<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">plaster</rdfs:label>
<rdfs:label xml:lang="fr">platre</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="CementRenderingTopic">
<rdfs:subClassOf rdf:resource="#CoatingTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">cement</rdfs:label>
<rdfs:label xml:lang="fr">ciment</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="InsulatorTopic">
<rdfs:subClassOf rdf:resource="#BuildingMaterialTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">insulator</rdfs:label>
<rdfs:label xml:lang="fr">isolant</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MetalTopic">
<rdfs:subClassOf rdf:resource="#BuildingMaterialTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">metal</rdfs:label>
<rdfs:label xml:lang="fr">metal</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="FerrousMetalTopic">
<rdfs:subClassOf rdf:resource="#MetalTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">ferrous metal</rdfs:label>
<rdfs:label xml:lang="fr">metal ferreux</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="NonFerroMetalTopic">
<rdfs:subClassOf rdf:resource="#MetalTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">non ferrous metal</rdfs:label>
<rdfs:label xml:lang="fr">metal non ferreux</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="MortarTopic">
<rdfs:subClassOf rdf:resource="#BuildingMaterialTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">mortar</rdfs:label>
<rdfs:label xml:lang="fr">mortier</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PaperMaterialTopic">
<rdfs:subClassOf rdf:resource="#BuildingMaterialTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">paper</rdfs:label>
<rdfs:label xml:lang="fr">papier</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="StoneMaterialTopic">
<rdfs:subClassOf rdf:resource="#BuildingMaterialTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">stone</rdfs:label>
<rdfs:label xml:lang="fr">pierre</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PolymerTopic">
<rdfs:subClassOf rdf:resource="#BuildingMaterialTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">polymer</rdfs:label>
<rdfs:label xml:lang="fr">polymere</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="EarthenwareTopic">
<rdfs:subClassOf rdf:resource="#BuildingMaterialTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">earthenware</rdfs:label>
<rdfs:label xml:lang="en">terracotta</rdfs:label>
<rdfs:label xml:lang="fr">terre cuite</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="BrickTopic">
<rdfs:subClassOf rdf:resource="#EarthenwareTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">brick</rdfs:label>
<rdfs:label xml:lang="fr">brique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="GlassMaterialTopic">
<rdfs:subClassOf rdf:resource="#BuildingMaterialTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">glass</rdfs:label>
<rdfs:label xml:lang="fr">verre</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="AsphaltTopic">
<rdfs:subClassOf rdf:resource="#BuildingMaterialTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">asphalt</rdfs:label>
<rdfs:label xml:lang="fr">bitume</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="BuildingProductTopic">
<rdfs:subClassOf
rdf:resource="#MaterialAndWorkTechnicsTopic"/>
<rdfs:comment xml:lang="en">25</rdfs:comment>
<rdfs:comment xml:lang="fr">25</rdfs:comment>
<rdfs:label xml:lang="en">building product</rdfs:label>
<rdfs:label xml:lang="fr">produit de
construction</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PathologyTopic">
<rdfs:subClassOf
rdf:resource="#MaterialAndWorkTechnicsTopic"/>
<rdfs:comment xml:lang="en">26</rdfs:comment>
<rdfs:comment xml:lang="fr">26</rdfs:comment>
<rdfs:label xml:lang="en">pathology</rdfs:label>
<rdfs:label xml:lang="fr">pathologie</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="CorrosionTopic">
<rdfs:subClassOf rdf:resource="#PathologyTopic"/>
<rdfs:comment xml:lang="en">26</rdfs:comment>
<rdfs:comment xml:lang="fr">26</rdfs:comment>
<rdfs:label xml:lang="en">corrosion</rdfs:label>
<rdfs:label xml:lang="fr">corrosion</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="BuildingSiteTopic">
<rdfs:subClassOf
rdf:resource="#MaterialAndWorkTechnicsTopic"/>
<rdfs:comment xml:lang="en">27</rdfs:comment>
<rdfs:comment xml:lang="fr">27</rdfs:comment>
<rdfs:label xml:lang="en">building site</rdfs:label>
<rdfs:label xml:lang="fr">chantier</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="BuildingTransversalTopic">
<rdfs:subClassOf rdf:resource="#BuildingTopic"/>
<rdfs:comment xml:lang="en">60</rdfs:comment>
<rdfs:comment xml:lang="fr">60</rdfs:comment>
<rdfs:label xml:lang="en">building transversal
theme</rdfs:label>
<rdfs:label xml:lang="fr">theme transversal de la
construction</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ArchitectureTopic">
<rdfs:subClassOf
rdf:resource="#BuildingTransversalTopic"/>
<rdfs:comment xml:lang="en">63</rdfs:comment>
<rdfs:comment xml:lang="fr">63</rdfs:comment>
<rdfs:label xml:lang="en">architecture</rdfs:label>
<rdfs:label xml:lang="fr">architecture</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="EnvironmentTopic">
<rdfs:subClassOf
rdf:resource="#BuildingTransversalTopic"/>
<rdfs:comment xml:lang="en">64</rdfs:comment>
<rdfs:comment xml:lang="fr">64</rdfs:comment>
<rdfs:label xml:lang="en">environment</rdfs:label>
<rdfs:label xml:lang="fr">environnement</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SecurityBuildingTopic">
<rdfs:subClassOf
rdf:resource="#BuildingTransversalTopic"/>
<rdfs:comment xml:lang="en">65</rdfs:comment>
<rdfs:comment xml:lang="fr">65</rdfs:comment>
<rdfs:label xml:lang="en">security</rdfs:label>
<rdfs:label xml:lang="fr">securite</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="HumanScienceTopic"> <rdfs:subClassOf
rdf:resource="#AdditionalTopic"/>
<rdfs:comment xml:lang="en">30</rdfs:comment>
<rdfs:comment xml:lang="fr">30</rdfs:comment>
<rdfs:label xml:lang="en">human science</rdfs:label>
<rdfs:label xml:lang="fr">science humaine</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="EconomicScienceTopic">
<rdfs:subClassOf rdf:resource="#AdditionalTopic"/>
<rdfs:comment xml:lang="en">30</rdfs:comment>
<rdfs:comment xml:lang="fr">30</rdfs:comment>
<rdfs:label xml:lang="en">economic science</rdfs:label>
<rdfs:label xml:lang="fr">science economique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SocialScienceTopic">
<rdfs:subClassOf rdf:resource="#AdditionalTopic"/>
<rdfs:subClassOf rdf:resource="#AdditionalTopic"/>
<rdfs:comment xml:lang="en">30</rdfs:comment>
<rdfs:comment xml:lang="fr">30</rdfs:comment>
<rdfs:label xml:lang="en">social science</rdfs:label>
<rdfs:label xml:lang="fr">science sociale</rdfs:label>
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</rdfs:Class>

<!-- Organizational view -->

<rdfs:Class rdf:ID="OrganizationalEntity">
<rdfs:subClassOf rdf:resource="#ManagementAbleEntity"/>
<rdfs:subClassOf rdf:resource="#ManageableEntity"/>
<rdfs:subClassOf
rdf:resource="#AdministrationAbleEntity"/>
<rdfs:subClassOf rdf:resource="#ActivityAbleEntity"/>
<rdfs:subClassOf rdf:resource="#InterestAbleEntity"/>
<rdfs:subClassOf rdf:resource="#SituableEntity"/>
<rdfs:subClassOf rdf:resource="#GroupAbleEntity"/>
<rdfs:subClassOf rdf:resource="#GatheringEntity"/>
<rdfs:comment xml:lang="en">Entity recognized by and
within the organization.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite identifiee par et dans
l organisation.</rdfs:comment>
<rdfs:label xml:lang="en">organizational
entity</rdfs:label>
<rdfs:label xml:lang="en">organisational
entity</rdfs:label>
<rdfs:label xml:lang="fr">entite
organisationnelle</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="OrganizationGroup">
<rdfs:subClassOf rdf:resource="#OrganizationalEntity"/>
<rdfs:comment xml:lang="en">An arganizational entity is
composed of other Organization Entity working together in
a structured way for a shared purpose.</rdfs:comment>
<rdfs:comment xml:lang="fr">Une entite organisationnelle
composee d autres entites d organisation fonctionnant
ensemble d une facon structuree avec un but
partage.</rdfs:comment>
<rdfs:label xml:lang="en">organization group</rdfs:label>
<rdfs:label xml:lang="en">organisation group</rdfs:label>
<rdfs:label xml:lang="fr">group d
organisation</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Organization">
<rdfs:subClassOf rdf:resource="#OrganizationGroup"/>
<rdfs:comment xml:lang="en">Organization Group including
both informal and legally constituted
organizations.</rdfs:comment>
<rdfs:comment xml:lang="fr">Groupe d organisation pouvant
etre des organismes non officiels ou legalement
constitues.</rdfs:comment>
<rdfs:label xml:lang="en">organization</rdfs:label>
<rdfs:label xml:lang="en">organisation</rdfs:label>
<rdfs:label xml:lang="fr">organisation</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Consortium">
<rdfs:subClassOf rdf:resource="#Organization"/>
<rdfs:comment xml:lang="en">Organization of several
Businesses joining together as a group for some shared
definite purpose.</rdfs:comment>
<rdfs:comment xml:lang="fr">Organisation de plusieurs
entreprises ou organismes s unissant en un groupe pour un
certain but defini et partage.</rdfs:comment>
<rdfs:label xml:lang="en">consortium</rdfs:label>
<rdfs:label xml:lang="fr">consortium</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Partner">
<rdfs:subClassOf rdf:resource="#Organization"/>
<rdfs:comment xml:lang="en"> Organization with which an
Organization is associated and collaborates. The
cooperation can be limited (e.g. for the realization of a
contract for a customer) or durable (mutual recognition of
the evaluation procedures and test results, institutional
partnership).</rdfs:comment>
<rdfs:comment xml:lang="fr">Organisation avec laquelle une
Organisation est associee et collabore. La cooperation
peut etre limitee(ex. realisation d un contrat pour un
client) ou durable (reconnaissance mutuelle des procedures
d evaluation et des tests sur les resultat, partenariat
institutionnel.</rdfs:comment>
<rdfs:label xml:lang="en">partner</rdfs:label>
<rdfs:label xml:lang="fr">partenaire</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Competitor">
<rdfs:subClassOf rdf:resource="#Organization"/>
<rdfs:comment xml:lang="en">Organization having similar
activities to an organization and trageting the same
markets.</rdfs:comment>
<rdfs:comment xml:lang="fr">Organisation ayant des
activites similaires a une organisation et a destination
des memes marches.</rdfs:comment>
<rdfs:label xml:lang="en">competitor</rdfs:label>
<rdfs:label xml:lang="fr">competiteur</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SupervisionAuthority">
<rdfs:subClassOf rdf:resource="#Organization"/>
<rdfs:comment xml:lang="en">Organization having the legal
authority to supervise the activities of other
organizations (ex. housing ministry).</rdfs:comment>
<rdfs:comment xml:lang="fr">Organization ayant l autorite
legale pour superviser les activites d autres
organisations (ex. ministere du logement).</rdfs:comment>
<rdfs:label xml:lang="en">supervision
authority</rdfs:label>
<rdfs:label xml:lang="fr">autorite de
supervision</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Customer">
<rdfs:subClassOf rdf:resource="#Organization"/>
<rdfs:comment xml:lang="en">Organization who pays for
goods or services.</rdfs:comment>
<rdfs:comment xml:lang="fr">Organisation payant pour
obtenir des biens ou des services.</rdfs:comment>
<rdfs:label xml:lang="en">customer</rdfs:label>
<rdfs:label xml:lang="en">client</rdfs:label>
<rdfs:label xml:lang="fr">client</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Subsidiary">
<rdfs:subClassOf rdf:resource="#Organization"/>
<rdfs:comment xml:lang="en">Organization that is
completely controlled by another.</rdfs:comment>
<rdfs:comment xml:lang="fr">Organisation entierement
controlee par une autre.</rdfs:comment>
<rdfs:label xml:lang="en">subsidiary</rdfs:label>
<rdfs:label xml:lang="fr">filiale</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="University">
<rdfs:subClassOf rdf:resource="#Organization"/>
<rdfs:comment xml:lang="en">Organization which does
university-level teaching and/or research.</rdfs:comment>
<rdfs:comment xml:lang="fr">Organisation qui enseigne
et/ou recherche au niveau universitaire. </rdfs:comment>
<rdfs:label xml:lang="en">university</rdfs:label>
<rdfs:label xml:lang="fr">universite</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="LegalCorporation">
<rdfs:subClassOf rdf:resource="#Organization"/>
<rdfs:comment xml:lang="en">Organization which is a
private, legal, corporate entity with the legal rights to
own property, able tomanage itself, and sue or be sued. It
is established by a charter or registration granted by a
government.</rdfs:comment>
<rdfs:comment xml:lang="fr">Organisation qui est une
entite privee, legale, ayant  droit a la propriete,
autonome, et capable poursuivre ou etre poursuivie en
justice. Elle est etablie par une charte ou un
enregistrement accorde par un gouvernement.</rdfs:comment>
<rdfs:label xml:lang="en">legal corporation</rdfs:label>
<rdfs:label xml:lang="fr">societe legale</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="OrganizationPart">
<rdfs:subClassOf rdf:resource="#OrganizationGroup"/>
<rdfs:comment xml:lang="en">Organization Group which is a
sub-organization of another Organization
Group.</rdfs:comment>
<rdfs:comment xml:lang="fr">Groupe d organisation qui est
une sous-organisation d un autre groupe.</rdfs:comment>
<rdfs:label xml:lang="en">organization part</rdfs:label>
<rdfs:label xml:lang="fr">partie d
organization</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Department">
<rdfs:subClassOf rdf:resource="#OrganizationPart"/>
<rdfs:comment xml:lang="en">Thematic grouping of
services.</rdfs:comment>
<rdfs:comment xml:lang="fr">Groupement thematique de
services.</rdfs:comment>
<rdfs:label xml:lang="en">department</rdfs:label>
<rdfs:label xml:lang="fr">departement</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ServiceGroup">
<rdfs:subClassOf rdf:resource="#OrganizationPart"/>
<rdfs:comment xml:lang="en">Basic functional unit. A
service is part of a department and is made up of several
divisions or poles.</rdfs:comment>
<rdfs:comment xml:lang="fr">Unite de base de l
organisation. Un service est une partie d un departement
et est compose de plusieurs divisions ou
poles.</rdfs:comment>
<rdfs:label xml:lang="en">service</rdfs:label>
<rdfs:label xml:lang="en">service group</rdfs:label>
<rdfs:label xml:lang="fr">service</rdfs:label>
<rdfs:label xml:lang="fr">groupe de service</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Division">
<rdfs:subClassOf rdf:resource="#OrganizationPart"/>
<rdfs:subClassOf rdf:resource="#GroupOfIndividuals"/>
<rdfs:comment xml:lang="en">Functional subdivision of a
service. It has generally 10 to 25 people.</rdfs:comment>
<rdfs:comment xml:lang="fr">Sous division fonctionnelle d
un service. Il compte en general 10 a 25
personnes.</rdfs:comment>
<rdfs:label xml:lang="en">division</rdfs:label>
<rdfs:label xml:lang="fr">division</rdfs:label>
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</rdfs:Class>

<rdfs:Class rdf:ID="Pole">
<rdfs:subClassOf rdf:resource="#OrganizationPart"/>
<rdfs:subClassOf rdf:resource="#GroupOfIndividuals"/>
<rdfs:comment xml:lang="en">Functional subdivision of a
service. It has generally 2 to 8 people.</rdfs:comment>
<rdfs:comment xml:lang="fr">Sous division fonctionnelle d
un service. Il compte en general 2 a 8
personnes.</rdfs:comment>
<rdfs:label xml:lang="en">pole</rdfs:label>
<rdfs:label xml:lang="fr">pole</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="TestLaboratory">
<rdfs:subClassOf rdf:resource="#OrganizationPart"/>
<rdfs:comment xml:lang="en">Group in charge of tests and
attached to a service or a division.</rdfs:comment>
<rdfs:comment xml:lang="fr">Groupe charge de realiser des
tests et attache a un service ou une
division.</rdfs:comment>
<rdfs:label xml:lang="en">test laboratory</rdfs:label>
<rdfs:label xml:lang="fr">laboratoire de test</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ManagementCommittee">
<rdfs:subClassOf rdf:resource="#OrganizationPart"/>
<rdfs:subClassOf rdf:resource="#GroupOfIndividuals"/>
<rdfs:comment xml:lang="en">Sub group of an organization
formed by the  President, the Director, the Director of
Research and Development and the Technical
Director.</rdfs:comment>
<rdfs:comment xml:lang="fr">Le sous groupe d une
organisation comprenant le president, le directeur, le
directeur de la recherche et du developpement et le
directeur technique.</rdfs:comment>
<rdfs:label xml:lang="en">management
committee</rdfs:label>
<rdfs:label xml:lang="fr">comite de gestion</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ManagementBoard">
<rdfs:subClassOf rdf:resource="#OrganizationPart"/>
<rdfs:subClassOf rdf:resource="#GroupOfIndividuals"/>
<rdfs:comment xml:lang="en">Sub group of an organization
formed by the heads of services.</rdfs:comment>
<rdfs:comment xml:lang="fr">Le sous groupe d une
organisation comprenant les chefs de
services.</rdfs:comment>
<rdfs:label xml:lang="en">management board</rdfs:label>
<rdfs:label xml:lang="fr">conseil de gestion</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Direction">
<rdfs:subClassOf rdf:resource="#OrganizationPart"/>
<rdfs:comment xml:lang="en">Organization part with a
special activity inside the company eg: HR, Project
Planning.</rdfs:comment>
<rdfs:comment xml:lang="fr">Sous partie d une organisation
avec une activite speciale a l interieur de la compagnie
par exemple: RH, Planification De Projet. </rdfs:comment>
<rdfs:label xml:lang="en">direction</rdfs:label>
<rdfs:label xml:lang="fr">direction</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Cluster">
<rdfs:subClassOf rdf:resource="#OrganizationPart"/>
<rdfs:comment xml:lang="en">Organization part grouping
projects according to their client type.</rdfs:comment>
<rdfs:comment xml:lang="fr">Partie d une organisation
groupant des sous parties d une organisation selon leur
type de client.</rdfs:comment>
<rdfs:label xml:lang="en">cluster</rdfs:label>
<rdfs:label xml:lang="fr">cluster</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ResearchDirection">
<rdfs:subClassOf rdf:resource="#OrganizationPart"/>
<rdfs:comment xml:lang="en">Organization Part responsible
for a specific technical field e.g. mobile
field.</rdfs:comment>
<rdfs:comment xml:lang="fr">Partie d une organisation
responsable d un domaine technique specifique par exemple
: les telephones mobiles.</rdfs:comment>
<rdfs:label xml:lang="en">research direction</rdfs:label>
<rdfs:label xml:lang="fr">research direction</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="GroupOfIndividuals">
<rdfs:subClassOf rdf:resource="#OrganizationGroup"/>
<rdfs:comment xml:lang="en">Organization Group composed of
individuals only.</rdfs:comment>
<rdfs:comment xml:lang="fr">Groupe d organisation composé
d individus uniquement.</rdfs:comment>
<rdfs:label xml:lang="en">group of
individuals</rdfs:label>
<rdfs:label xml:lang="fr">groupe d individus</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Association">
<rdfs:subClassOf rdf:resource="#GroupOfIndividuals"/>
<rdfs:comment xml:lang="en">Formal group of individuals
who have an interest, an activity, or a purpose in
common.</rdfs:comment>
<rdfs:comment xml:lang="fr">Groupe formel d individus qui
ont un interet, une activite, ou un but en
commun.</rdfs:comment>
<rdfs:label xml:lang="en">association</rdfs:label>
<rdfs:label xml:lang="fr">association</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="BenevolentAssociation">
<rdfs:subClassOf rdf:resource="#Association"/>
<rdfs:comment xml:lang="en">Association which helps a
particular group of people in need.</rdfs:comment>
<rdfs:comment xml:lang="fr">Association qui aide un groupe
de personnes particulier dans le besoin.</rdfs:comment>
<rdfs:label xml:lang="en">benevolent
association</rdfs:label>
<rdfs:label xml:lang="fr">association de
bienveillance</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Club">
<rdfs:subClassOf rdf:resource="#GroupOfIndividuals"/>
<rdfs:comment xml:lang="en">Group of individuals with a
common purpose or interest who meet regularly and take
part in shared activities.</rdfs:comment>
<rdfs:comment xml:lang="fr">Groupe d individus avec un but
ou un interet commun qui se reunissent regulierement et
participent a des activites collectives.</rdfs:comment>
<rdfs:label xml:lang="en">club</rdfs:label>
<rdfs:label xml:lang="fr">club</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Union">
<rdfs:subClassOf rdf:resource="#GroupOfIndividuals"/>
<rdfs:comment xml:lang="en">Group of individuals formed to
bargain with the employer.</rdfs:comment>
<rdfs:comment xml:lang="fr">Groupe d individus forme pour
negocier avec l employeur.</rdfs:comment>
<rdfs:label xml:lang="en">union</rdfs:label>
<rdfs:label xml:lang="fr">syndicat</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Unit">
<rdfs:subClassOf rdf:resource="#GroupOfIndividuals"/>
<rdfs:comment xml:lang="en">Group of individuals
corresponding to a group of researchers focusing on a sub
interest field e.g.: microwaves.</rdfs:comment>
<rdfs:comment xml:lang="fr">Groupe d individus
correspondant a un groupe de chercheurs se focalisant sur
un domaine d interet par exemple: micro-
ondes.</rdfs:comment>
<rdfs:label xml:lang="en">unit</rdfs:label>
<rdfs:label xml:lang="fr">unite</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ProjectGroup">
<rdfs:subClassOf rdf:resource="#GroupOfIndividuals"/>
<rdfs:comment xml:lang="en">Temporary group of individual
working on a planned activity for a client with an
associated fixed budget.</rdfs:comment>
<rdfs:comment xml:lang="fr">Groupe provisoire d
individuels sur une activite planifiee pour un client avec
un budget fixe alloue.</rdfs:comment>
<rdfs:label xml:lang="en">project group</rdfs:label>
<rdfs:label xml:lang="en">project</rdfs:label>
<rdfs:label xml:lang="fr">groupe de projet</rdfs:label>
<rdfs:label xml:lang="fr">projet</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="InternationalOrganizationGroup">
<rdfs:subClassOf rdf:resource="#OrganizationGroup"/>
<rdfs:comment xml:lang="en">Organization Group of
international scope, that is, one which has substantial
operations, physical facilities, or substantial membership
in multiple countries.</rdfs:comment>
<rdfs:comment xml:lang="fr">Groupe d organisation de
portee internationale, c.-a-d., qui a des operations
substantielles ou des implantations dans des pays
multiples.</rdfs:comment>
<rdfs:label xml:lang="en">international
organization</rdfs:label>
<rdfs:label xml:lang="en">multinational</rdfs:label>
<rdfs:label xml:lang="fr">organisation
internationale</rdfs:label>
<rdfs:label xml:lang="fr">multinationale</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="NationalOrganizationGroup">
<rdfs:subClassOf rdf:resource="#OrganizationGroup"/>
<rdfs:comment xml:lang="en">Organization Group of
nationwide scope, that is distribution throughout some
Country of its members and/or activities.</rdfs:comment>
<rdfs:comment xml:lang="fr">Groupe d organisation de
portee nationale,avec une distribution dans tout le pays
de ses membres et/ou activites.</rdfs:comment>
<rdfs:label xml:lang="en">national
organization</rdfs:label>
<rdfs:label xml:lang="en">national organisation
group</rdfs:label>
<rdfs:label xml:lang="fr">organisation
nationale</rdfs:label>
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</rdfs:Class>

<rdfs:Class rdf:ID="LocalOrganizationGroup">
<rdfs:subClassOf rdf:resource="#OrganizationGroup"/>
<rdfs:comment xml:lang="en">Organization Group of local
scope, that is, members distributed in a local area - a
Neighborhood, City, rural region, etc. -  or having a
local area of activity and concern.</rdfs:comment>
<rdfs:comment xml:lang="fr">Groupe d organisation de
portee locale, c.-a-d., avec ses membres distribues dans
une zone locale - un voisinage, une ville, une region
rurale, etc. - ou ayant un secteur d activite
local.</rdfs:comment>
<rdfs:label xml:lang="en">local organization</rdfs:label>
<rdfs:label xml:lang="en">regional
organization</rdfs:label>
<rdfs:label xml:lang="en">local organisation</rdfs:label>
<rdfs:label xml:lang="en">regional
organisation</rdfs:label>
<rdfs:label xml:lang="fr">organisation locale</rdfs:label>
<rdfs:label xml:lang="fr">organisation
regionale</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SingleSiteOrganizationGroup">
<rdfs:subClassOf rdf:resource="#OrganizationGroup"/>
<rdfs:comment xml:lang="en">Organization Group which has a
single location as its physical quarters.</rdfs:comment>
<rdfs:comment xml:lang="fr">Groupe d organisation qui a un
emplacement simple qui est son centre d
activite.</rdfs:comment>
<rdfs:label xml:lang="en">single site
organization</rdfs:label>
<rdfs:label xml:lang="fr">organisation un unique
site</rdfs:label>
</rdfs:Class>


<!-- document medium -->

<rdfs:Class rdf:ID="DocumentaryMedium">
<rdfs:subClassOf rdf:resource="#PhysicalEntity"/>
<rdfs:comment xml:lang="en">Physical entity through which
signals/messages travel as a means for
communication.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite physique par laquelle
voyage des signaux/messages comme moyens de
transmission.</rdfs:comment>
<rdfs:label xml:lang="en">documentary medium</rdfs:label>
<rdfs:label xml:lang="fr">support
documentaire</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Paper">
<rdfs:subClassOf rdf:resource="#DocumentaryMedium"/>
<rdfs:comment xml:lang="en">Documentary Medium which is a
thin flat material, made from crushed wood or cloth and
used for writing, printing or drawing on.</rdfs:comment>
<rdfs:comment xml:lang="fr">Support documentaire qui est
un materiel plat et mince, fait a partir du bois ou du
tissu ecrase et utilise pour l ecriture, l impression ou
le dessin. </rdfs:comment>
<rdfs:label xml:lang="en">paper</rdfs:label>
<rdfs:label xml:lang="fr">papier</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="RecordTape">
<rdfs:subClassOf rdf:resource="#DocumentaryMedium"/>
<rdfs:comment xml:lang="en">Documentary Medium where the
recording is done on a magnetic tape.</rdfs:comment>
<rdfs:comment xml:lang="fr">Support documentaire pour
lequel l enregistrement est fait sur une bande
magnetique.</rdfs:comment>
<rdfs:label xml:lang="en">record tape</rdfs:label>
<rdfs:label xml:lang="fr">bande magnetique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="DVD">
<rdfs:subClassOf rdf:resource="#DocumentaryMedium"/>
<rdfs:comment xml:lang="en">Digital Medium where the
Documentary Element is recorded on a optical disc called
Digital Versatile Disc or Digital Video
Disc.</rdfs:comment>
<rdfs:comment xml:lang="fr">Support numeric ou l element
documentaire est enregistre sur un disque optique appele
disque polyvalent numerique ou disque video
numerique.</rdfs:comment>
<rdfs:label xml:lang="en">DVD</rdfs:label>
<rdfs:label xml:lang="en">D.V.D.</rdfs:label>
<rdfs:label xml:lang="en">digital versatile
disc</rdfs:label>
<rdfs:label xml:lang="en">digital video disc</rdfs:label>
<rdfs:label xml:lang="fr">DVD</rdfs:label>
<rdfs:label xml:lang="fr">D.V.D.</rdfs:label>
<rdfs:label xml:lang="fr">disque polyvalent
numerique</rdfs:label>
<rdfs:label xml:lang="fr">disque video
numerique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="DVD-ROM">
<rdfs:subClassOf rdf:resource="#DVD"/>
<rdfs:comment xml:lang="en">DVD used for storing computer
data.</rdfs:comment>
<rdfs:comment xml:lang="fr">DVD utilise pour enregistrer
des donnees informatiques.</rdfs:comment>
<rdfs:label xml:lang="en">DVD-ROM</rdfs:label>
<rdfs:label xml:lang="fr">DVD-ROM</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="CD">
<rdfs:subClassOf rdf:resource="#DocumentaryMedium"/>
<rdfs:comment xml:lang="en">Digital Medium where the
Documentary Element is recorded on a optical
disc.</rdfs:comment>
<rdfs:comment xml:lang="fr">Support numerique pour lequel
l element documentaire est enregistre sur un disque
optique.</rdfs:comment>
<rdfs:label xml:lang="en">CD</rdfs:label>
<rdfs:label xml:lang="en">C.D.</rdfs:label>
<rdfs:label xml:lang="en">compact disc</rdfs:label>
<rdfs:label xml:lang="fr">CD</rdfs:label>
<rdfs:label xml:lang="fr">C.D.</rdfs:label>
<rdfs:label xml:lang="fr">disque compact</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="AudioCD">
<rdfs:subClassOf rdf:resource="#CD"/>
<rdfs:comment xml:lang="en">CD where the Documentary
Element uses Audio Perception and is recorded using hi-fi
music industry format.</rdfs:comment>
<rdfs:comment xml:lang="fr">CD ou l element documentaire
utilise la perception sonore et est enregistre en
utilisant le format haute fidelite d industrie de
musique.</rdfs:comment>
<rdfs:label xml:lang="en">audio CD</rdfs:label>
<rdfs:label xml:lang="en">audio compact disc</rdfs:label>
<rdfs:label xml:lang="fr">CD audio</rdfs:label>
<rdfs:label xml:lang="fr">disque compact
audio</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="CD-ROM">
<rdfs:subClassOf rdf:resource="#CD"/>
<rdfs:comment xml:lang="en">CD used for storing computer
data.</rdfs:comment>
<rdfs:comment xml:lang="fr">CD utilise pour enregistrer
des donnees d ordinateur.</rdfs:comment>
<rdfs:label xml:lang="en">CD-ROM</rdfs:label>
<rdfs:label xml:lang="fr">CD-ROM</rdfs:label>
</rdfs:Class>


<!-- Documents -->

<rdfs:Class rdf:ID="Document">
<rdfs:subClassOf rdf:resource="#Entity"/>
<rdfs:subClassOf rdf:resource="#EntityConcerningATopic"/>
<rdfs:subClassOf rdf:resource="#NumberableEntity"/>
<rdfs:comment xml:lang="en">Entity including elements
serving as a representation of thinking.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite comprenant des elements
de representation de la pensee.</rdfs:comment>
<rdfs:label xml:lang="en">document</rdfs:label>
<rdfs:label xml:lang="fr">document</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Memo">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document corresponding to a
message or other information in writing sent by one person
or department to another in the same
Organization.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document correspondant a un
message ou a toute autre information ecrite envoyee par
une personne ou un service a l autre dans la meme
organisation.</rdfs:comment>
<rdfs:label xml:lang="en">memo</rdfs:label>
<rdfs:label xml:lang="fr">memo</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="NewsgroupMessage">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document corresponding to
messages displayed on the Internet and devoted to the
discussion of a specified topic.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document correspondant a un
message affiche sur l Internet et participant a une
discussion sur un sujet bien specifique.</rdfs:comment>
<rdfs:label xml:lang="en">newsgroup message</rdfs:label>
<rdfs:label xml:lang="en">forum message</rdfs:label>
<rdfs:label xml:lang="fr">message de
newsgroup</rdfs:label>
<rdfs:label xml:lang="fr">message de forum</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Mail">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Documents sent and delivered
through a dedicated conveyance network.</rdfs:comment>
<rdfs:comment xml:lang="fr">Documents envoyes et delivres
par un reseau dedie de transport.</rdfs:comment>
<rdfs:label xml:lang="en">mail</rdfs:label>
<rdfs:label xml:lang="fr">courrier</rdfs:label>
</rdfs:Class>
```

```
<rdfs:Class rdf:ID="E-Mail">
<rdfs:subClassOf rdf:resource="#Mail"/>
<rdfs:comment xml:lang="en">Mail sent in electronic format
over a computerized world-wide communication
system.</rdfs:comment>
<rdfs:comment xml:lang="fr">Courrier envoye au format
electronique a travers un systeme mondial de transmission
automatisee.</rdfs:comment>
<rdfs:label xml:lang="en">e-mail</rdfs:label>
<rdfs:label xml:lang="en">electronic mail</rdfs:label>
<rdfs:label xml:lang="en">mail</rdfs:label>
<rdfs:label xml:lang="fr">mel</rdfs:label>
<rdfs:label xml:lang="fr">courrier
electronique</rdfs:label>
<rdfs:label xml:lang="fr">mail</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PostMail">
<rdfs:subClassOf rdf:resource="#Mail"/>
<rdfs:comment xml:lang="en">Mail transmitted via the post
office.</rdfs:comment>
<rdfs:comment xml:lang="fr">Courrier transmis par l
intermediaire de la poste.</rdfs:comment>
<rdfs:label xml:lang="en">post mail</rdfs:label>
<rdfs:label xml:lang="en">mail</rdfs:label>
<rdfs:label xml:lang="fr">courrier</rdfs:label>
<rdfs:label xml:lang="fr">courrier postal</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Letter">
<rdfs:subClassOf rdf:resource="#PostMail"/>
<rdfs:comment xml:lang="en">Post Mail written or printed,
usually put in an envelope and respecting a standard
presentation.</rdfs:comment>
<rdfs:comment xml:lang="fr">Courrier Postal ecrit ou
imprime, habituellement mis sous pli et respectant une
presentation standard.</rdfs:comment>
<rdfs:label xml:lang="en">letter</rdfs:label>
<rdfs:label xml:lang="fr">lettre</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Postcard">
<rdfs:subClassOf rdf:resource="#PostMail"/>
<rdfs:comment xml:lang="en">Post Mail consisting in a
small, rectangular card, usually with a picture on one
side and a message on the other, that can be sent without
an envelope.</rdfs:comment>
<rdfs:comment xml:lang="fr">Courrier postal consistant en
une petite carte rectangulaire habituellement avec une
image sur un cote et un message de l autre, et qui peut
etre envoyee sans enveloppe.</rdfs:comment>
<rdfs:label xml:lang="en">postcard</rdfs:label>
<rdfs:label xml:lang="fr">carte postale</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="InternMail">
<rdfs:subClassOf rdf:resource="#Mail"/>
<rdfs:comment xml:lang="en">Mail transmitted via an
Organization internal post system.</rdfs:comment>
<rdfs:comment xml:lang="fr">Courrier transmis par l
intermediaire d un systeme de poste interne a l
organisation.</rdfs:comment>
<rdfs:label xml:lang="en">intern mail</rdfs:label>
<rdfs:label xml:lang="fr">courrier interne</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Report">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document, usually a concise
one, on a well defined topic and taking into account the
identity of the readers.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document, habituellement
concis, sur un sujet bien defini et tenant compte de l
identite des lecteurs.</rdfs:comment>
<rdfs:label xml:lang="en">report</rdfs:label>
<rdfs:label xml:lang="fr">rapport</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="AnnualReport">
<rdfs:subClassOf rdf:resource="#Report"/>
<rdfs:comment xml:lang="en">Report of the formal financial
statements and operations, issued by a corporation to its
shareholders after its fiscal year-end.</rdfs:comment>
<rdfs:comment xml:lang="fr">Rapport des comptes financiers
et des operations, emis par une societe pour ses
actionnaires apres sa fin d annee fiscale.</rdfs:comment>
<rdfs:label xml:lang="en">annual report</rdfs:label>
<rdfs:label xml:lang="fr">rapport annuel</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ResearchReport">
<rdfs:subClassOf rdf:resource="#Report"/>
<rdfs:comment xml:lang="en">Report presenting
studies.</rdfs:comment>
<rdfs:comment xml:lang="fr">Rapport presentant des
etudes.</rdfs:comment>
<rdfs:label xml:lang="en">research report</rdfs:label>
<rdfs:label xml:lang="fr">rapport de
recherche</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="TechnicalReport">
<rdfs:subClassOf rdf:resource="#Report"/>
<rdfs:comment xml:lang="en">Report presenting technical
results.</rdfs:comment>
<rdfs:comment xml:lang="fr">Rapport presentant des
resultats, des points, techniques.</rdfs:comment>
<rdfs:label xml:lang="en">technical report</rdfs:label>
<rdfs:label xml:lang="fr">rapport technique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ConsultancyReport">
<rdfs:subClassOf rdf:resource="#Report"/>
<rdfs:comment xml:lang="en">Report on studies performed
for clients. Most of them are confidential.</rdfs:comment>
<rdfs:comment xml:lang="fr">Rapport au sujet d etudes
realisees pour des clients. La plupart d entre eux sont
confidentiels.</rdfs:comment>
<rdfs:label xml:lang="en">consultancy report</rdfs:label>
<rdfs:label xml:lang="fr">rapport de
consultance</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="TrainingPeriodReport">
<rdfs:subClassOf rdf:resource="#Report"/>
<rdfs:comment xml:lang="en">Report written by a trainee at
the end of its training period. Rarely confidential, these
reports deal with very restricted area.</rdfs:comment>
<rdfs:comment xml:lang="fr">Rapport ecrit par un stagiaire
a la fin de son stage. Rarement confidentiels, ces
rapports traitent d un sujet restreint.</rdfs:comment>
<rdfs:label xml:lang="en">training period
report</rdfs:label>
<rdfs:label xml:lang="fr">rapport de stage</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="FinalReport">
<rdfs:subClassOf rdf:resource="#Report"/>
<rdfs:comment xml:lang="en">Report concluding and
synthesizing the results of a research action or a
consultancy contract.</rdfs:comment>
<rdfs:comment xml:lang="fr">Rapport concluant et resumant
les resultats d une action de recherches ou d un contrat
de consultance.</rdfs:comment>
<rdfs:label xml:lang="en">final report</rdfs:label>
<rdfs:label xml:lang="fr">rapport final</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="IntermediateReport">
<rdfs:subClassOf rdf:resource="#Report"/>
<rdfs:comment xml:lang="en">Punctual report produced at
the end of each step of a research action or a consultancy
contract (state of the art, experiment…).</rdfs:comment>
<rdfs:comment xml:lang="fr">Rapport produit a la fin de
chaque etape d une action de recherche ou d un contrat de
consultance (etat de l art, experience).</rdfs:comment>
<rdfs:label xml:lang="en">intermediate report</rdfs:label>
<rdfs:label xml:lang="fr">rapport
intermediaire</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="News">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:subClassOf rdf:resource="#ExtractedDocument"/>
<rdfs:comment xml:lang="en">Document about recent
events.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document au sujet d evenements
recents.</rdfs:comment>
<rdfs:label xml:lang="en">news</rdfs:label>
<rdfs:label xml:lang="fr">nouvelle</rdfs:label>
<rdfs:label xml:lang="fr">news</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="NewsLetter">
<rdfs:subClassOf rdf:resource="#News"/>
<rdfs:subClassOf rdf:resource="#ISSNHolderDocument"/>
<rdfs:comment xml:lang="en">News issued to members of an
Organization.</rdfs:comment>
<rdfs:comment xml:lang="fr">Nouvelles emises aux membres d
une organisation.</rdfs:comment>
<rdfs:label xml:lang="en">news letter</rdfs:label>
<rdfs:label xml:lang="fr">lettre d
information</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="IndexCard">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document for categorising
services, applications, company s market operations, etc..
This is a useful way to represent information when the
emphasis is put on some specific point of innovation
rather than on a very detailed description of the single
service, application or fact.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document approprie pour
classer des services, des applications, des operations de
la compagnie sur le marche, etc. par categorie. C est une
facon utile de representer l information quand l emphase
est mise sur un certain point specifique d innovation
plutot que sur une description tres detaillee du service,
de l application ou du fait decrit.</rdfs:comment>
<rdfs:label xml:lang="en">index card</rdfs:label>
<rdfs:label xml:lang="fr">fiche</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="TrendAnalysis">
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<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Synthesis Document written by
an expert on the trends of a technological
area.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document de synthese ecrit par
un expert sur les tendances d un domaine
technologique.</rdfs:comment>
<rdfs:label xml:lang="en">trend analysis</rdfs:label>
<rdfs:label xml:lang="fr">analyse de tendance</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ScenarioAnalysis">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document based on available
information about technologies, proposing potential medium
term strategic scenarios. Reasonably there will be only a
few reports of this kind in a year.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document base sur les
informations disponibles sur des technologies, proposant
des scenarios strategiques a moyen terme. Raisonnablement
il y aura seulement quelques rapports de ce type chaque
annee.</rdfs:comment>
<rdfs:label xml:lang="en">scenario analysis</rdfs:label>
<rdfs:label xml:lang="fr">analyse de scenario</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Article">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:subClassOf rdf:resource="#ExtractedDocument"/>
<rdfs:comment xml:lang="en">Document corresponding to a
piece of writing on a particular subject and which purpose
is to fully realize a particular objective in a relatively
concise form e.g.: demonstrate something.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document correspondant un
texte sur un sujet particulier et qui a pour but de
realiser un objectif particulier sous une forme
relativement concise, par exemple : demontrer quelque
chose.</rdfs:comment>
<rdfs:label xml:lang="en">article</rdfs:label>
<rdfs:label xml:lang="fr">article</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Abstract">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document corresponding to a
summary of another document.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document correspondant au
resume d un autre document.</rdfs:comment>
<rdfs:label xml:lang="en">abstract</rdfs:label>
<rdfs:label xml:lang="fr">resume</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Proceedings">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document containing a written
account of what transpired at a event and the documents
presented by the actors of the event.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document contenant un compte
rendu de ce qui s est produit lors d un evenement et des
documents presentes par les acteurs de l
evenement.</rdfs:comment>
<rdfs:label xml:lang="en">proceedings</rdfs:label>
<rdfs:label xml:lang="fr">actes</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Thesis">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document corresponding to a
long piece of writing on a particular subject advancing a
new point of view resulting from research ; it is usually
a requirement for an advanced academic
degree.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document correspondant a un
long texte sur un sujet particulier proposant un nouveau
point de vue resultant de la recherche ; c est
habituellement une condition pour un l obtention d un
doctorat.</rdfs:comment>
<rdfs:label xml:lang="en">thesis</rdfs:label>
<rdfs:label xml:lang="fr">these</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Minutes">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document containing of written
record of what was said at a meeting.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document contenant l
enregistrement ecrit de ce qui a ete dit lors d une
reunion.</rdfs:comment>
<rdfs:label xml:lang="en">minutes</rdfs:label>
<rdfs:label xml:lang="fr">minutes</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Transparency">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document of one page usually
concise and prepared to be presented to a public by
projection.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document d une page
habituellement concis et prepare pour etre presente a un
public par projection.</rdfs:comment>
<rdfs:label xml:lang="en">transparency</rdfs:label>
<rdfs:label xml:lang="en">slide</rdfs:label>
<rdfs:label xml:lang="fr">transparent</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="TransparencyShow">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document corresponding to an
ordered set of transparencies usually grouped around a
topic.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document correspondant a un
ensemble ordonne de transparents habituellement groupes
autour d un sujet.</rdfs:comment>
<rdfs:label xml:lang="en">transparency show</rdfs:label>
<rdfs:label xml:lang="fr">presentation</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ReferenceDocument">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document to which you can
refer for authoritative facts.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document auquel vous pouvez
vous referer pour des faits bien fondes.</rdfs:comment>
<rdfs:label xml:lang="en">reference document</rdfs:label>
<rdfs:label xml:lang="fr">document de
reference</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Standard">
<rdfs:subClassOf rdf:resource="#ReferenceDocument"/>
<rdfs:subClassOf rdf:resource="#NumberableEntity"/>
<rdfs:comment xml:lang="en">Reference used as a point of
reference to compare and evaluate quality of products or
systems.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document utilise comme un
point de reference pour comparer et evaluer la qualite des
produits ou des systemes.</rdfs:comment>
<rdfs:label xml:lang="en">dictionary</rdfs:label>
<rdfs:label xml:lang="fr">dictionnaire</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Dictionary">
<rdfs:subClassOf rdf:resource="#ReferenceDocument"/>
<rdfs:comment xml:lang="en">Reference Document in which
words are listed alphabetically and their
meanings.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document de reference dans
lequel des mots sont enumeres alphabetiquement avec leurs
significations.</rdfs:comment>
<rdfs:label xml:lang="en">dictionary</rdfs:label>
<rdfs:label xml:lang="fr">dictionnaire</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Lexicon">
<rdfs:subClassOf rdf:resource="#Dictionary"/>
<rdfs:comment xml:lang="en">Dictionary usually small and
limited to a particular language or
subject.</rdfs:comment>
<rdfs:comment xml:lang="fr">Dictionnaire habituellement
petit et limite e un langage ou e un sujet
particulier.</rdfs:comment>
<rdfs:label xml:lang="en">lexicon</rdfs:label>
<rdfs:label xml:lang="fr">lexique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Manual">
<rdfs:subClassOf rdf:resource="#ReferenceDocument"/>
<rdfs:comment xml:lang="en">Reference Document which gives
you practical instructions on how to do something or how
to use something, such as a machine.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document de reference qui vous
donne des instructions pratiques sur la facon de faire
quelque chose ou la facon d utiliser quelque chose, telle
qu une machine.</rdfs:comment>
<rdfs:label xml:lang="en">manual</rdfs:label>
<rdfs:label xml:lang="en">instructions</rdfs:label>
<rdfs:label xml:lang="fr">manuel</rdfs:label>
<rdfs:label xml:lang="fr">instructions</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Nomenclature">
<rdfs:subClassOf rdf:resource="#ReferenceDocument"/>
<rdfs:comment xml:lang="en">Reference Document which gives
a system for naming things, especially in a particular
area of science.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document de reference qui
donne un systeme pour nommer des choses, particulierement
dans un secteur scientifique particulier.</rdfs:comment>
<rdfs:label xml:lang="en">nomenclature</rdfs:label>
<rdfs:label xml:lang="fr">nomenclature</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Catalog">
<rdfs:subClassOf rdf:resource="#ReferenceDocument"/>
<rdfs:comment xml:lang="en">Reference document containing
an enumeration of things usually linked to a domain or an
activity.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document de reference
contenant une enumuration de choses habituellement liees a
un domaine ou a une activite.</rdfs:comment>
<rdfs:label xml:lang="en">catalog</rdfs:label>
<rdfs:label xml:lang="en">catalogue</rdfs:label>
<rdfs:label xml:lang="fr">catalogue</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="EmployeeManual">
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<rdfs:subClassOf rdf:resource="#Manual"/>
<rdfs:comment xml:lang="en">Manual that officially
explains company policies, procedures, and
benefits.</rdfs:comment>
<rdfs:comment xml:lang="fr">Manuel qui explique
officiellement les politiques, les procedures, et des
avantages de la compagnie.</rdfs:comment>
<rdfs:label xml:lang="en">employee manual</rdfs:label>
<rdfs:label xml:lang="fr">manuel de l employe</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="CodeOfConduct">
<rdfs:subClassOf rdf:resource="#Manual"/>
<rdfs:comment xml:lang="en">Manual that makes explicit the
expectations governing the behavior of those agents
subject to it in certain kinds of
situations.</rdfs:comment>
<rdfs:comment xml:lang="fr">Manuel qui rend explicite les
attentes regissant le comportement des agents sujet a ce
code dans des situations donnees.</rdfs:comment>
<rdfs:label xml:lang="en">code of conduct</rdfs:label>
<rdfs:label xml:lang="fr">code de conduite</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="OrganizationPolicy">
<rdfs:subClassOf rdf:resource="#Manual"/>
<rdfs:comment xml:lang="en">Manual that contains the terms
of some policy of a particular
organization.</rdfs:comment>
<rdfs:comment xml:lang="fr">Manuel qui decrit les termes d
une politique d une organisation
particuliere.</rdfs:comment>
<rdfs:label xml:lang="en">organization policy</rdfs:label>
<rdfs:label xml:lang="en">corporate policy</rdfs:label>
<rdfs:label xml:lang="fr">politique d
entreprise</rdfs:label>
<rdfs:label xml:lang="fr">politique
organisationnelle</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Encyclopedia">
<rdfs:subClassOf rdf:resource="#ReferenceDocument"/>
<rdfs:comment xml:lang="en">Reference Document usually
rather large and containing many articles arranged in
alphabetical order which deal either with the whole of
human knowledge or with a particular part of
it.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document de reference
habituellement plutot grand et contenant beaucoup d
articles disposes dans l ordre alphabetique qui traitent
de la totalite de la connaissance humaine ou un domaine
particulier.</rdfs:comment>
<rdfs:label xml:lang="en">encyclopedia</rdfs:label>
<rdfs:label xml:lang="en">encyclopaedia</rdfs:label>
<rdfs:label xml:lang="fr">encyclopedie</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="WebPage">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document corresponding to a
page on the World Wide Web.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document correspondant a une
page sur le World Wide Web.</rdfs:comment>
<rdfs:label xml:lang="en">web page</rdfs:label>
<rdfs:label xml:lang="en">web site</rdfs:label>
<rdfs:label xml:lang="fr">page web</rdfs:label>
<rdfs:label xml:lang="fr">site web</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Homepage">
<rdfs:subClassOf rdf:resource="#WebPage"/>
<rdfs:comment xml:lang="en">Web Page designed to be the
main page of a Web site. Typically, the home page serves
as an index or table of contents to other documents stored
at the site.</rdfs:comment>
<rdfs:comment xml:lang="fr">Page Web concue pour etre la
page principale d un site Web. Typiquement, cette page d
accueil sert d index ou de table des matieres aux autres
documents du site.</rdfs:comment>
<rdfs:label xml:lang="en">home page</rdfs:label>
<rdfs:label xml:lang="en">welcome page</rdfs:label>
<rdfs:label xml:lang="en">homepage</rdfs:label>
<rdfs:label xml:lang="fr">page d accueil</rdfs:label>
<rdfs:label xml:lang="fr">page principale</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="OrganizationalHomePage">
<rdfs:subClassOf rdf:resource="#Homepage"/>
<rdfs:comment xml:lang="en">Homepage of an Organization s
Web Site.</rdfs:comment>
<rdfs:comment xml:lang="fr">Page d accueil du site Web d
une organisation.</rdfs:comment>
<rdfs:label xml:lang="en">organization
homepage</rdfs:label>
<rdfs:label xml:lang="fr">page d accueil d une
organisation</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PersonalHomePage">
<rdfs:subClassOf rdf:resource="#Homepage"/>
<rdfs:comment xml:lang="en">Homepage of a Person s Web
Site</rdfs:comment>
<rdfs:comment xml:lang="fr">Page d accueil du site Web d
une personne.</rdfs:comment>
<rdfs:label xml:lang="en">personal homepage</rdfs:label>
<rdfs:label xml:lang="fr">page personnelle</rdfs:label>
<rdfs:label xml:lang="fr">site personnel</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="WebSite">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document made up of
interconnected Web Pages, usually including a Homepage,
generally located on the same server, and prepared and
maintained as a collection of information by a person,
group, or organization.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document compose des pages Web
interconnectees, comprenant habituellement une page d
accueil, et generalement localisees sur le meme serveur,
preparees et mises a jour par une personne, un groupe, ou
une organisation pour collecter des
informations.</rdfs:comment>
<rdfs:label xml:lang="en">web site</rdfs:label>
<rdfs:label xml:lang="fr">site web</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="OfficialDocument">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document agreed to or arranged
by people in positions of authority.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document revu, vise ou prepare
par des personnes en position d autorite.</rdfs:comment>
<rdfs:label xml:lang="en">official document</rdfs:label>
<rdfs:label xml:lang="fr">document officiel</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Patent">
<rdfs:subClassOf rdf:resource="#OfficialDocument"/>
<rdfs:subClassOf rdf:resource="#NumberableEntity"/>
<rdfs:comment xml:lang="en">Official document that confers
upon the creator of an invention the sole right to make,
use, and sell that invention for a given period of
time.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document officiel qui confere
au createur d une invention le droit unique de faire,
utiliser, et vendre cette invention pendant une periode de
temps fixee.</rdfs:comment>
<rdfs:label xml:lang="en">patent</rdfs:label>
<rdfs:label xml:lang="fr">brevet</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Index">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document consisting of summary
list of other items.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document se composant de la
liste recapitulative d autres elements.</rdfs:comment>
<rdfs:label xml:lang="en">index</rdfs:label>
<rdfs:label xml:lang="fr">index</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Book">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document consisting of a set
of pages to be fastened together inside a cover to be
read.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document se composant d un
ensemble de pages a attacher ensemble a l interieur d une
couverture afin de les lire.</rdfs:comment>
<rdfs:label xml:lang="en">book</rdfs:label>
<rdfs:label xml:lang="fr">livre</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Booklet">
<rdfs:subClassOf rdf:resource="#Book"/>
<rdfs:comment xml:lang="en">Book (small) with a small
number of pages often giving information about
something.</rdfs:comment>
<rdfs:comment xml:lang="fr">Livre (petit) avec un nombre
restreint de pages fournissant souvent des informations
sur quelque chose. </rdfs:comment>
<rdfs:label xml:lang="en">booklet</rdfs:label>
<rdfs:label xml:lang="en">leaflet</rdfs:label>
<rdfs:label xml:lang="en">pamphlet</rdfs:label>
<rdfs:label xml:lang="fr">prospectus</rdfs:label>
<rdfs:label xml:lang="fr">brochure</rdfs:label>
<rdfs:label xml:lang="fr">tract</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Chart">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document corresponding to a
visual display of information often intended to show the
information more clearly.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document la correspondant a
une visualisation d information souvent destinee a montrer
l information de facon plus claire.</rdfs:comment>
<rdfs:label xml:lang="en">chart</rdfs:label>
<rdfs:label xml:lang="fr">representation
graphique</rdfs:label>
</rdfs:Class>


<rdfs:Class rdf:ID="Graph">
<rdfs:subClassOf rdf:resource="#Chart"/>
```

```
<rdfs:comment xml:lang="en">Chart which shows a series of
points, lines, line segments, curves, or areas that
represents the variation of a variable in comparison with
that of one or more other variables.</rdfs:comment>
<rdfs:comment xml:lang="fr">Representation graphique qui
montre une serie de points, de lignes, de segments de
ligne, de courbes, ou de zones qui represente la variation
d une variable en comparaison de celle d une ou plusieurs
autres.</rdfs:comment>
<rdfs:label xml:lang="en">graph</rdfs:label>
<rdfs:label xml:lang="fr">graphique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Diagram">
<rdfs:subClassOf rdf:resource="#Chart"/>
<rdfs:comment xml:lang="en">Chart intended to explain how
something works a drawing showing the relation between the
parts.</rdfs:comment>
<rdfs:comment xml:lang="fr">Representation graphique a
destine a expliquer comment quelque chose fonctionne un
dessin montrant la relation entre les differents elements.
</rdfs:comment>
<rdfs:label xml:lang="en">diagram</rdfs:label>
<rdfs:label xml:lang="fr">diagramme</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="OrganizationChart">
<rdfs:subClassOf rdf:resource="#Diagram"/>
<rdfs:comment xml:lang="en">Diagram that graphically or in
outline fashion depicts information about the control
structure or resource use structure of an
organization.</rdfs:comment>
<rdfs:comment xml:lang="fr">Diagramme qui donne
graphiquement ou schematiquement des informations sur la
structure de controle ou la structure d utilisation des
ressources d une organisation.</rdfs:comment>
<rdfs:label xml:lang="en">organization chart</rdfs:label>
<rdfs:label xml:lang="fr">organigramme</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Flowchart">
<rdfs:subClassOf rdf:resource="#Diagram"/>
<rdfs:comment xml:lang="en">Diagram which shows the stages
of a process.</rdfs:comment>
<rdfs:comment xml:lang="fr">Diagramme qui montre les
etapes d un processus.</rdfs:comment>
<rdfs:label xml:lang="en">flowchart</rdfs:label>
<rdfs:label xml:lang="fr">organigramme</rdfs:label>
<rdfs:label xml:lang="fr">plan d action</rdfs:label>
<rdfs:label xml:lang="fr">diagramme de
processus</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Map">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document which, properly
interpreted, models a region of physical space many times
its own size by using graphical symbols - or possibly
another code -, often in conjunction with a natural
language.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document qui, correctement
interprete, modele une region de l espace physique
beaucoup plus grande en utilisant des symboles graphiques
- ou  un autre code - et souvent le langage
naturel.</rdfs:comment>
<rdfs:label xml:lang="en">map</rdfs:label>
<rdfs:label xml:lang="fr">carte</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Logo">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document showing the emblem of
a group.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document montrant l embleme d
un groupe.</rdfs:comment>
<rdfs:label xml:lang="en">logo</rdfs:label>
<rdfs:label xml:lang="fr">logo</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Speech">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document corresponding to a
formal talk given usually to a large number of people on a
special occasion.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document la correspondant a un
expose formel presente habituellement a un grand nombre de
personnes pour une occasion speciale.</rdfs:comment>
<rdfs:label xml:lang="en">speech</rdfs:label>
<rdfs:label xml:lang="fr">discours</rdfs:label>
<rdfs:label xml:lang="fr">allocution</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Presentation">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document presenting news or
other information and intended to be broadcasted or
printed.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document presentant des
nouvelles ou toute autre information et destine a etre
annoncee ou imprimee.</rdfs:comment>
<rdfs:label xml:lang="en">presentation</rdfs:label>
<rdfs:label xml:lang="fr">presentation</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Narration">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document corresponding to an
account describing incidents or events.</rdfs:comment>
<rdfs:comment xml:lang="en">Document la correspondant un
compte decrivant des incidents ou des
evenements.</rdfs:comment>
<rdfs:label xml:lang="en">narration</rdfs:label>
<rdfs:label xml:lang="en">story</rdfs:label>
<rdfs:label xml:lang="en">account</rdfs:label>
<rdfs:label xml:lang="fr">narration</rdfs:label>
<rdfs:label xml:lang="fr">histoire</rdfs:label>
<rdfs:label xml:lang="fr">compte rendu</rdfs:label>
<rdfs:label xml:lang="fr">recit</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Illustration">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document corresponding to
artworks that help make something clear or
attractive.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document correspondant aux
dessins qui aident a rendre quelque chose plus clair ou
plus attrayant.</rdfs:comment>
<rdfs:label xml:lang="en">illustration</rdfs:label>
<rdfs:label xml:lang="fr">illustration</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Spreadsheet">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document with multiple columns
and rows to organize data for calculating and making
adjustments based on new data.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document avec de multiples
colonnes et lignes pour organiser des donnees pour
calculer et automatisant les ajustements dus a de
nouvelles donnees.</rdfs:comment>
<rdfs:label xml:lang="en">spreadsheet</rdfs:label>
<rdfs:label xml:lang="en">spread sheet</rdfs:label>
<rdfs:label xml:lang="fr">tableau</rdfs:label>
<rdfs:label xml:lang="fr">feuille de tableur</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Form">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document for structured
solicitation of input from a user.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document pour solliciter de
facon structuree l expression d informations donnees par
les utilisateurs.</rdfs:comment>
<rdfs:label xml:lang="en">form</rdfs:label>
<rdfs:label xml:lang="fr">formulaire</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="OrderForm">
<rdfs:subClassOf rdf:resource="#Form"/>
<rdfs:comment xml:lang="en">Form which a customer uses to
request goods or a service.</rdfs:comment>
<rdfs:comment xml:lang="fr">Formulaire qu un client
utilise pour demander des marchandises ou un
service.</rdfs:comment>
<rdfs:label xml:lang="en">order form</rdfs:label>
<rdfs:label xml:lang="fr">formulaire de
commande</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="InformationForm">
<rdfs:subClassOf rdf:resource="#Form"/>
<rdfs:comment xml:lang="en">Form for engineers and
researchers to share their (informal)
information.</rdfs:comment>
<rdfs:comment xml:lang="fr">Formulaire pour que les
ingenieurs et les chercheurs partagent des information
(informelles).</rdfs:comment>
<rdfs:label xml:lang="en">information form</rdfs:label>
<rdfs:label xml:lang="fr">formulaire d
information</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Advertisement">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Document of a public
announcement, especially to proclaim the qualities or
advantages of some product or service so as to increase
sales.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document d une annonce
publique, particulierement pour clamer les qualites ou les
avantages d un certain produit ou service afin d augmenter
des ventes.</rdfs:comment>
<rdfs:label xml:lang="en">advertisement</rdfs:label>
<rdfs:label xml:lang="en">publicity</rdfs:label>
<rdfs:label xml:lang="en">promotion</rdfs:label>
<rdfs:label xml:lang="fr">annonce</rdfs:label>
<rdfs:label xml:lang="fr">publicite</rdfs:label>
<rdfs:label xml:lang="fr">reclame</rdfs:label>
<rdfs:label xml:lang="fr">promotion</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Journal">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:subClassOf rdf:resource="#ISSNHolderDocument"/>
```

```
<rdfs:comment xml:lang="en">Document corresponding to a
serious magazine or newspaper which is published
regularly, usually about a specialist
subject.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document correspondant un
magazine, une revue ou un journal serieux, edite
regulierement, habituellement avec sujet
specialise.</rdfs:comment>
<rdfs:label xml:lang="en">journal</rdfs:label>
<rdfs:label xml:lang="fr">journal</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Newspaper">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:subClassOf rdf:resource="#ISSNHolderDocument"/>
<rdfs:comment xml:lang="en">Document regularly printed and
consisting of news reports, articles, photographs and
advertisements, and that is usually intended to be printed
on a daily or weekly basis on large sheets of paper which
are folded together but not permanently
joined.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document regulierement imprime
et compose nouvelles, d article, de photographies et d
annonces, et habituellement destine a etre imprime
quotidiennement ou de facon hebdomadaire sur de grande
feuille papier que l on peut plier ensemble et qui ne sont
pas reliees.</rdfs:comment>
<rdfs:label xml:lang="en">newspaper</rdfs:label>
<rdfs:label xml:lang="fr">journal</rdfs:label>
<rdfs:label xml:lang="fr">quotidien</rdfs:label>
<rdfs:label xml:lang="fr">hebdomadaire</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Magazine">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:subClassOf rdf:resource="#ISSNHolderDocument"/>
<rdfs:comment xml:lang="en">Document corresponding to a
type of thin book with large pages which contains articles
and photographs. It is usually intended to be a weekly or
monthly paperback publication.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document correspondant a un
type de livre mince avec de grandes pages qui contient des
articles et des photographies. On le destine
habituellement a une publication hebdomadaire ou mensuelle
sous la forme d un livret broche.</rdfs:comment>
<rdfs:label xml:lang="en">magazine</rdfs:label>
<rdfs:label xml:lang="fr">magazine</rdfs:label>
<rdfs:label xml:lang="fr">revue</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="DocumentaryFile">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Thematic document, regularly
updated and made with heterogeneous material (articles,
references, synthesis…).</rdfs:comment>
<rdfs:comment xml:lang="fr">Document thematique,
regulierement mis a jour et compose de materiel heterogene
(articles, references, synthese). </rdfs:comment>
<rdfs:label xml:lang="en">documentary file</rdfs:label>
<rdfs:label xml:lang="fr">fichier
documentaire</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="CourseDocument">
<rdfs:subClassOf rdf:resource="#Document"/>
<rdfs:comment xml:lang="en">Training document containing
pedagogical material and usually used by lecturers or
teachers as a support of their lessons.</rdfs:comment>
<rdfs:comment xml:lang="fr">Document de formation
contenant le materiel pedagogique et habituellement
utilise par des conferenciers ou des professeurs comme
support de leurs lecons.</rdfs:comment>
<rdfs:label xml:lang="en">course</rdfs:label>
<rdfs:label xml:lang="en">training document</rdfs:label>
<rdfs:label xml:lang="fr">cours</rdfs:label>
<rdfs:label xml:lang="fr">materiel
pedagogique</rdfs:label>
</rdfs:Class>

<!-- Time -->

<rdfs:Class rdf:ID="TimeEntity">
<rdfs:subClassOf rdf:resource="#Entity"/>
<rdfs:comment xml:lang="en">Entity related to the
continuum of experience in which events pass from the
future through the present to the past.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite liee au continuum d
experience dans lequel les evenements passent du futur par
le present vers le passe.</rdfs:comment>
<rdfs:label xml:lang="en">time entity</rdfs:label>
<rdfs:label xml:lang="fr">entite temporelle</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="TimePoint">
<rdfs:subClassOf rdf:resource="#TimeEntity"/>
<rdfs:comment xml:lang="en">Time Entity corresponding to a
particular, instantaneous point in time.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite temporelle
correspondant a un point particulier et instantane du
temps.</rdfs:comment>
<rdfs:label xml:lang="en">time point</rdfs:label>
<rdfs:label xml:lang="fr">point du temps</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Date">
<rdfs:subClassOf rdf:resource="#TimeEntity"/>
<rdfs:comment xml:lang="en">Time Entity corresponding a
numbered day in a month, often given with a combination of
the name of the day, the month and the
year.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite temporelle
correspondant un jour numerote dans un mois, souvent donne
par une combinaison du nom du jour, de son numero, du mois
et de l annee.</rdfs:comment>
<rdfs:label xml:lang="en">date</rdfs:label>
<rdfs:label xml:lang="fr">date</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ClockTime">
<rdfs:subClassOf rdf:resource="#TimeEntity"/>
<rdfs:comment xml:lang="en">Time Entity corresponding to a
time of day.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite temporelle
correspondant a une heure de la journee.</rdfs:comment>
<rdfs:label xml:lang="en">clock time</rdfs:label>
<rdfs:label xml:lang="en">time</rdfs:label>
<rdfs:label xml:lang="fr">heure</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Duration">
<rdfs:subClassOf rdf:resource="#TimeEntity"/>
<rdfs:comment xml:lang="en">Time Entity corresponding to
the length of time that something lasts.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite temporelle
correspondant a la quantite de temps prise par quelque
chose.</rdfs:comment>
<rdfs:label xml:lang="en">duration</rdfs:label>
<rdfs:label xml:lang="fr">duree</rdfs:label>
</rdfs:Class>


<!-- Geography -->

<rdfs:Class rdf:ID="Location">
<rdfs:subClassOf rdf:resource="#SpatialEntity"/>
<rdfs:subClassOf rdf:resource="#NumberableEntity"/>
<rdfs:comment xml:lang="en">Spatial Entity which is a
point or an extent in space.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite spatiale qui est un
point ou une ampleur dans l espace.</rdfs:comment>
<rdfs:label xml:lang="en">location</rdfs:label>
<rdfs:label xml:lang="fr">emplacement</rdfs:label>
</rdfs:Class>


<!-- People -->

<rdfs:Class rdf:ID="Person">
<rdfs:subClassOf rdf:resource="#ManageableEntity"/>
<rdfs:subClassOf
rdf:resource="#AdministrationAbleEntity"/>
<rdfs:subClassOf rdf:resource="#ActivityAbleEntity"/>
<rdfs:subClassOf rdf:resource="#LivingEntity"/>
<rdfs:subClassOf rdf:resource="#InterestAbleEntity"/>
<rdfs:subClassOf rdf:resource="#SituableEntity"/>
<rdfs:subClassOf rdf:resource="#GroupAbleEntity"/>
<rdfs:subClassOf rdf:resource="#GatheringEntity"/>
<rdfs:subClassOf rdf:resource="#NumberableEntity"/>
<rdfs:comment xml:lang="en">Living Entity belonging to
mankind, an individual human being.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite vivante appartenant a l
humanite, un etre humain individuel. </rdfs:comment>
<rdfs:label xml:lang="en">person</rdfs:label>
<rdfs:label xml:lang="en">human</rdfs:label>
<rdfs:label xml:lang="en">human being</rdfs:label>
<rdfs:label xml:lang="fr">personne</rdfs:label>
<rdfs:label xml:lang="fr">humain</rdfs:label>
<rdfs:label xml:lang="fr">etre humain</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Professional">
<rdfs:subClassOf rdf:resource="#Person"/>
<rdfs:comment xml:lang="en">Person who does activities
that are characteristic of some job/profession/occupation
for a livelihood.</rdfs:comment>
<rdfs:comment xml:lang="fr">Personne qui a des activites
caracteristiques d un certain travail / profession /
metier pour gagner sa vie.</rdfs:comment>
<rdfs:label xml:lang="en">professional</rdfs:label>
<rdfs:label xml:lang="fr">professionnel</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Employee">
<rdfs:subClassOf rdf:resource="#Professional"/>
<rdfs:comment xml:lang="en">Professional who works for an
organization in return for financial or other
compensation. Disjoint with Self-employed
Professional.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professionnel qui travaille
pour une organisation en echange d argent ou toute autre
compensation. Disjoint avec les professionnel
independants. </rdfs:comment>
<rdfs:label xml:lang="en">employee</rdfs:label>
<rdfs:label xml:lang="fr">employe</rdfs:label>
</rdfs:Class>
```

```
<rdfs:Class rdf:ID="AuditorInspector">
<rdfs:subClassOf rdf:resource="#Professional"/>
<rdfs:comment xml:lang="en">Professional performs
audit.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professionnel accomplissant
des audits. </rdfs:comment>
<rdfs:label xml:lang="en">auditor</rdfs:label>
<rdfs:label xml:lang="en">inspector</rdfs:label>
<rdfs:label xml:lang="fr">inspecteur</rdfs:label>
<rdfs:label xml:lang="fr">auditeur</rdfs:label>
<rdfs:label xml:lang="fr">audit</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ExternalPeople">
<rdfs:subClassOf rdf:resource="#Professional"/>
<rdfs:comment xml:lang="en">Professional from an
organization but working for another for a limited period
of time.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professionnel d organisation
mais travaillant pour une autre organisation durant une
periode de temps limitee.</rdfs:comment>
<rdfs:label xml:lang="en">external people</rdfs:label>
<rdfs:label xml:lang="fr">personne exterieure</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Head">
<rdfs:subClassOf rdf:resource="#Professional"/>
<rdfs:comment xml:lang="en">Professional responsible for
an organization part.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professional responsable d une
partie d une organisation.</rdfs:comment>
<rdfs:label xml:lang="en">head</rdfs:label>
<rdfs:label xml:lang="fr">chef</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="HeadOfDepartment">
<rdfs:subClassOf rdf:resource="#Head"/>
<rdfs:comment xml:lang="en">Professional responsible for a
department.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professional responsable d un
departement.</rdfs:comment>
<rdfs:label xml:lang="en">head of department</rdfs:label>
<rdfs:label xml:lang="fr">chef de departement</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="HeadOfService">
<rdfs:subClassOf rdf:resource="#Head"/>
<rdfs:comment xml:lang="en">Professional responsible for a
service.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professional responsable d un
service.</rdfs:comment>
<rdfs:label xml:lang="en">head of service</rdfs:label>
<rdfs:label xml:lang="fr">chef de service</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="HeadOfDivision">
<rdfs:subClassOf rdf:resource="#Head"/>
<rdfs:comment xml:lang="en">Professional responsible for a
division.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professional responsable d une
division.</rdfs:comment>
<rdfs:label xml:lang="en">head of division</rdfs:label>
<rdfs:label xml:lang="fr">chef de division</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="HeadOfPole">
<rdfs:subClassOf rdf:resource="#Head"/>
<rdfs:comment xml:lang="en">Professional responsible for a
pole.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professional responsable d un
pole.</rdfs:comment>
<rdfs:label xml:lang="en">head of pole</rdfs:label>
<rdfs:label xml:lang="fr">chef de pole</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="HeadOfProject">
<rdfs:subClassOf rdf:resource="#Head"/>
<rdfs:comment xml:lang="en">Professional responsible for a
project.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professional responsable d un
projet.</rdfs:comment>
<rdfs:label xml:lang="en">head of project</rdfs:label>
<rdfs:label xml:lang="fr">chef de projet</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="HeadOfTestLaboratory">
<rdfs:subClassOf rdf:resource="#Head"/>
<rdfs:comment xml:lang="en">Professional responsible for a
laboratory.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professional responsable d un
laboratoire.</rdfs:comment>
<rdfs:label xml:lang="en">head of laboratory</rdfs:label>
<rdfs:label xml:lang="en">laboratory manager</rdfs:label>
<rdfs:label xml:lang="fr">chef de laboratoire</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Engineer">
<rdfs:subClassOf rdf:resource="#Professional"/>
<rdfs:comment xml:lang="en">Professional who works in some
branch of engineering using scientific knowledge to solve
practical problems.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professionnel qui travaille
dans une certaine branche d ingenierie ou l on utilise la
connaissance scientifique pour resoudre des problemes
pratiques.</rdfs:comment>
<rdfs:label xml:lang="en">engineer</rdfs:label>
<rdfs:label xml:lang="fr">ingenieur</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Technician">
<rdfs:subClassOf rdf:resource="#Professional"/>
<rdfs:comment xml:lang="en">Professional trained in some
specific technical processes.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professionnel qualifie dans
quelques processus techniques specifiques.</rdfs:comment>
<rdfs:label xml:lang="en">technician</rdfs:label>
<rdfs:label xml:lang="fr">technicien</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Worker">
<rdfs:subClassOf rdf:resource="#Professional"/>
<rdfs:comment xml:lang="en">Professional member of the
working class with a specific job.</rdfs:comment>
<rdfs:comment xml:lang="fr">Membre professionnel de la
classe ouvriere assurant un travail
specifique.</rdfs:comment>
<rdfs:label xml:lang="en">worker</rdfs:label>
<rdfs:label xml:lang="fr">ouvrier</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Researcher">
<rdfs:subClassOf rdf:resource="#Professional"/>
<rdfs:comment xml:lang="en">Professional working in the
Activity Field of Research, carrying out detailed study of
a subject, esp. in order to discover - new - information
or reach a - new - understanding.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professionnel travaillant dans
le domaine d activite de la recherche, effectuant des
etudes detaillees sur un sujet, afin de decouvrir en
particulier de - nouvelles - informations ou d atteindre
une - nouvelle - comprehension.</rdfs:comment>
<rdfs:label xml:lang="en">researcher</rdfs:label>
<rdfs:label xml:lang="fr">chercheur</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Scientist">
<rdfs:subClassOf rdf:resource="#Professional"/>
<rdfs:comment xml:lang="en">Professional educated and
employed in one - or more - of the natural or abstract
sciences.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professionnel instruit et
employe dans une - ou plusieurs - sciences naturelles ou
abstraites.</rdfs:comment>
<rdfs:label xml:lang="en">scientist</rdfs:label>
<rdfs:label xml:lang="fr">scientifique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Manager">
<rdfs:subClassOf rdf:resource="#Professional"/>
<rdfs:subClassOf rdf:resource="#ManagementAbleEntity"/>
<rdfs:comment xml:lang="en">Professional whose primary job
is to manage other people, directing their work activity.
A Manager tells his or her subordinate workers what to
do.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professionnel dont le travail
principal est de diriger et controler d autres personnes,
dirigeant leur activite de travail. Un gestionnaire fixe a
ses employes subalternes leur charge de
travail.</rdfs:comment>
<rdfs:label xml:lang="en">manager</rdfs:label>
<rdfs:label xml:lang="en">chief</rdfs:label>
<rdfs:label xml:lang="fr">dirigeant</rdfs:label>
<rdfs:label xml:lang="fr">directeur</rdfs:label>
<rdfs:label xml:lang="fr">responsable</rdfs:label>
<rdfs:label xml:lang="fr">chef</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Administrator">
<rdfs:subClassOf rdf:resource="#Professional"/>
<rdfs:comment xml:lang="en">Professional who is
responsible for managing its organizational affairs.
Administrator may or may not also be required to manage
people. If so, then they are also Managers.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professionnel qui est
responsable de contreler les affaires d une organisation.
Un administrateur peut (ou non) egalement etre amene a
diriger et controler des personnes. Si oui, alors ils est
aussi un dirigeant.</rdfs:comment>

<rdfs:label xml:lang="en">administrator</rdfs:label>
<rdfs:label xml:lang="fr">administrateur</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Assistant">
<rdfs:subClassOf rdf:resource="#Professional"/>
<rdfs:comment xml:lang="en">Professional that contributes
to the fulfillment of a need or furtherance of an effort
or purpose.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professionnel qui contribue a
la realisation d un travail ou d une aide, d un effort.
</rdfs:comment>
<rdfs:label xml:lang="en">assistant</rdfs:label>
<rdfs:label xml:lang="fr">assistant</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Secretary">
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<rdfs:subClassOf rdf:resource="#Assistant"/>
<rdfs:comment xml:lang="en">Assistant who handles
correspondence and clerical work for a boss or an
organization.</rdfs:comment>
<rdfs:comment xml:lang="fr">Assistant qui s occupe de la
correspondance / du courrier et du travail de bureau pour
un patron ou une organisation. </rdfs:comment>
<rdfs:label xml:lang="en">secretary</rdfs:label>
<rdfs:label xml:lang="fr">secretaire</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Executive">
<rdfs:subClassOf rdf:resource="#Professional"/>
<rdfs:comment xml:lang="en">Professional who holds a high
position in some Organization, makes decisions and puts
them into action.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professionnel qui tient une
position elevee dans une certaine organisation, prend des
decisions et les met en action.</rdfs:comment>
<rdfs:label xml:lang="en">executive</rdfs:label>
<rdfs:label xml:lang="fr">cadre</rdfs:label>
<rdfs:label xml:lang="fr">executif</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Consultant">
<rdfs:subClassOf rdf:resource="#Professional"/>
<rdfs:comment xml:lang="en">Professional who works with
some business in a consulting capacity.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professionnel qui travaille
avec des organisations vendant ses conseils et son
expertise.</rdfs:comment>
<rdfs:label xml:lang="en">consultant</rdfs:label>
<rdfs:label xml:lang="fr">consultant</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Salesperson">
<rdfs:subClassOf rdf:resource="#Professional"/>
<rdfs:comment xml:lang="en">Professional employed to sell
merchandise to customers in a store or to customers that
are visited.</rdfs:comment>
<rdfs:comment xml:lang="fr">Professionnel employe pour
vendre des marchandises aux clients dans un magasin ou aux
clients a qui il rendu visite.</rdfs:comment>
<rdfs:label xml:lang="en">sales assistant</rdfs:label>
<rdfs:label xml:lang="en">sales man</rdfs:label>
<rdfs:label xml:lang="en">shop assistant</rdfs:label>
<rdfs:label xml:lang="en">sales clerk</rdfs:label>
<rdfs:label xml:lang="fr">vendeur</rdfs:label>
<rdfs:label xml:lang="fr">representant de
commerce</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Student">
<rdfs:subClassOf rdf:resource="#Person"/>
<rdfs:comment xml:lang="en">Person who studies at an
academic institution. This collection includes students at
all levels of study in all types of educational
institutions.</rdfs:comment>
<rdfs:comment xml:lang="fr">Personne qui eudie dans un
etablissement scolaire. Ceci inclut les etudiants a tous
les niveaux d etude dans tous les types d etablissements
educatifs.</rdfs:comment>
<rdfs:label xml:lang="en">student</rdfs:label>
<rdfs:label xml:lang="fr">etudiant</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PhDStudent">
<rdfs:subClassOf rdf:resource="#Researcher"/>
<rdfs:subClassOf rdf:resource="#Student"/>
<rdfs:comment xml:lang="en">Student carrying supervised
research usually based on at least 3 years graduate study
and a dissertation to obtain a Ph.D./doctorate (the
highest degree awarded by a graduate
school).</rdfs:comment>
<rdfs:comment xml:lang="fr">Etudiant effectuant des
recherches encadrees generalement sur trois ans avec une
soutenance finale afin d obtenir un diplome de
thèse/doctorat (plus haute distinction
scolaire).</rdfs:comment>
<rdfs:label xml:lang="en">Ph.D. student</rdfs:label>
<rdfs:label xml:lang="fr">etudiant en these</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PostDoctorate">
<rdfs:subClassOf rdf:resource="#Researcher"/>
<rdfs:comment xml:lang="en">Student who recently finished
his Ph.D. and has a contract with a limited duration to
continue his search.</rdfs:comment>
<rdfs:comment xml:lang="fr">Etudiant qui a recemment
termine son doctorat et beneficie d un contrat a duree
limitee pour poursuivre ses recherches.</rdfs:comment>
<rdfs:label xml:lang="en">Post-doctorate</rdfs:label>
<rdfs:label xml:lang="fr">Post-doctorant</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Trainee">
<rdfs:subClassOf rdf:resource="#Student"/>
<rdfs:comment xml:lang="en">Student who is being trained
during an internship the organization.</rdfs:comment>
<rdfs:comment xml:lang="fr">Etudiant en formation dans l
organisation dans le cadre d un stage.</rdfs:comment>
<rdfs:label xml:lang="en">trainee</rdfs:label>
<rdfs:label xml:lang="fr">stagiaire</rdfs:label>
</rdfs:Class>

<!-- Technology Monitoring -->

<rdfs:Class rdf:ID="TechnologyMonitoringActor">
<rdfs:subClassOf rdf:resource="#Person"/>
<rdfs:comment xml:lang="en">A Person playing a role in
technology monitoring process.</rdfs:comment>
<rdfs:comment xml:lang="fr">Une personne jouant un role
dans le processus de veille technologique.</rdfs:comment>
<rdfs:label xml:lang="en">technology monitoring
actor</rdfs:label>
<rdfs:label xml:lang="fr">acteur de la veille
technologique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Observer">
<rdfs:subClassOf
rdf:resource="#TechnologyMonitoringActor"/>
<rdfs:comment xml:lang="en">Technical monitoring actor
required to monitor and filter all the technical and
strategic documentation on innovative services they came
across and send anything they judge as interesting input
for the technology monitoring process to his area
referent.</rdfs:comment>
<rdfs:comment xml:lang="fr">Acteur de la veille
technologique en charge de surveiller et filtrer la
documentation technique strategique a propos de services
innovateurs qu il a trouve et d envoyer tout ce qu il juge
interessant pour le domaine dont il est en charge a son
referent de domaine.</rdfs:comment>
<rdfs:label xml:lang="en">observer</rdfs:label>
<rdfs:label xml:lang="fr">observateur</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="AreaReferent">
<rdfs:subClassOf
rdf:resource="#TechnologyMonitoringActor"/>
<rdfs:comment xml:lang="en">Technical monitoring actor
responsible for an expertise area and who has a group of
contributors observers to manage.</rdfs:comment>
<rdfs:comment xml:lang="fr">Acteur de la veille
technologique responsable d un domaine d expertise et qui
a un groupe d observateurs contributeurs a
diriger.</rdfs:comment>
<rdfs:label xml:lang="en">area referent</rdfs:label>
<rdfs:label xml:lang="fr">referent de domaine</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Archivist">
<rdfs:subClassOf
rdf:resource="#TechnologyMonitoringActor"/>
<rdfs:comment xml:lang="en">Technical monitoring actor
responsible for library activities.</rdfs:comment>
<rdfs:comment xml:lang="fr">Acteur de la veille
technologique responsable de l archivage.</rdfs:comment>
<rdfs:label xml:lang="en">archivist</rdfs:label>
<rdfs:label xml:lang="fr">archiviste</rdfs:label>
</rdfs:Class>

<!-- Integration Process -->

<rdfs:Class rdf:ID="IntegrationProcessActor">
<rdfs:subClassOf rdf:resource="#Person"/>
<rdfs:comment xml:lang="en">A Person playing a role in the
newcomer integration process.</rdfs:comment>
<rdfs:comment xml:lang="fr">Une personne jouant un role
dans le processus d integration d un nouvel
arrivant.</rdfs:comment>
<rdfs:label xml:lang="en">integration process
actor</rdfs:label>
<rdfs:label xml:lang="fr">acteur du processus d
integration</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Tutor">
<rdfs:subClassOf rdf:resource="#IntegrationProcessActor"/>
<rdfs:comment xml:lang="en">A person who gives private
advice and instruction to a newcomer.</rdfs:comment>
<rdfs:comment xml:lang="fr">Personne qui conseil et forme
un nouvel arrivant.</rdfs:comment>
<rdfs:label xml:lang="en">tutor</rdfs:label>
<rdfs:label xml:lang="fr">tuteur</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Newcomer">
<rdfs:subClassOf rdf:resource="#IntegrationProcessActor"/>
<rdfs:comment xml:lang="en">Person newly arrived in the
company.</rdfs:comment>
<rdfs:comment xml:lang="fr">Personne nouvellement arrivee
dans une compagnie.</rdfs:comment>
<rdfs:label xml:lang="en">newcomer</rdfs:label>
<rdfs:label xml:lang="fr">nouveau venu</rdfs:label>
<rdfs:label xml:lang="fr">nouvel arrivant</rdfs:label>
</rdfs:Class>

<!-- Event -->

<rdfs:Class rdf:ID="Event">
<rdfs:subClassOf rdf:resource="#Something"/>
<rdfs:comment xml:lang="en">Thing taking place, happening,
occurring and usually recognized as important, significant
or unusual.</rdfs:comment>
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<rdfs:comment xml:lang="fr">Chose ayant lieu, se
produisant et habituellement reconnu comme importante,
significative ou peu commune.</rdfs:comment>
<rdfs:label xml:lang="en">event</rdfs:label>
<rdfs:label xml:lang="fr">evenement</rdfs:label>

</rdfs:Class>

<rdfs:Class rdf:ID="Gathering">
<rdfs:subClassOf rdf:resource="#Event"/>
<rdfs:subClassOf rdf:resource="#SituableEntity"/>
<rdfs:subClassOf rdf:resource="#EntityConcerningATopic"/>
<rdfs:comment xml:lang="en">Event corresponding to the
social act of a group of Persons assembling in one
place.</rdfs:comment>
<rdfs:comment xml:lang="fr">Evenement correspondant a l
acte social dun groupe de personnes se reunissant dans un
lieu.</rdfs:comment>
<rdfs:label xml:lang="en">gathering</rdfs:label>
<rdfs:label xml:lang="fr">rassemblement</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PublicGathering">
<rdfs:subClassOf rdf:resource="#Gathering"/>
<rdfs:comment xml:lang="en">Gathering allowing anyone to
see or hear what is happening.</rdfs:comment>
<rdfs:comment xml:lang="fr">Rassemblement ou n importe qui
peut voir ou entendre ce qui se produit.</rdfs:comment>
<rdfs:label xml:lang="en">public gathering</rdfs:label>
<rdfs:label xml:lang="fr">rassemblement
publique</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PrivateGathering">
<rdfs:subClassOf rdf:resource="#Gathering"/>
<rdfs:comment xml:lang="en">Gathering restricted to one
particular group, not to other people.</rdfs:comment>
<rdfs:comment xml:lang="fr">Rassemblement limite e un
groupe particulier, et pas aux autres.</rdfs:comment>
<rdfs:label xml:lang="en">private gathering</rdfs:label>
<rdfs:label xml:lang="fr">rassemblement prive</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="InformalGathering">
<rdfs:subClassOf rdf:resource="#Gathering"/>
<rdfs:comment xml:lang="en">Gathering without official
forms - of clothing, behavior, speech -  not according to
conventional, prescribed, or customary forms or rules
hence, without ceremony not officially recognized or
controlled, usually having or fostering a warm or friendly
atmosphere, especially through smallness.</rdfs:comment>
<rdfs:comment xml:lang="fr">Rassemblement sans formalites
officielles - d habillement, comportement, parole - pas
selon des formes ou des regles conventionnelles,
prescrites, ou usuelles par consequent, sans ceremonie,
pas officiellement reconnu ou controle, et ayant
habituellement une atmosphere chaleureuse ou amicale,
souvent de petite dimension. </rdfs:comment>
<rdfs:label xml:lang="en">informal gathering</rdfs:label>
<rdfs:label xml:lang="fr">rassemblement
informel</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="FormalGathering">
<rdfs:subClassOf rdf:resource="#Gathering"/>
<rdfs:comment xml:lang="en">Gathering agreeable to
established mode, forms, conventions and requirements,
methodical well planned and organized, not incidental,
sudden or irregular.</rdfs:comment>
<rdfs:comment xml:lang="fr">Rassemblement conforme au
mode, aux formes, aux conventions et aux conditions
etablis, methodiquement bien a planifie et organise, non
fortuit. </rdfs:comment>
<rdfs:label xml:lang="en">formal gathering</rdfs:label>
<rdfs:label xml:lang="fr">rassemblement
formel</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Meeting">
<rdfs:subClassOf rdf:resource="#FormalGathering"/>
<rdfs:comment xml:lang="en">Gathering formally arranged
for a particular purpose, usually in a dedicated room
and/or around a table.</rdfs:comment>
<rdfs:comment xml:lang="fr">Rassemblement formel pour un
but particulier, habituellement dans une salle dediee
et/ou autour d une table.</rdfs:comment>
<rdfs:label xml:lang="en">meeting</rdfs:label>
<rdfs:label xml:lang="fr">reunion</rdfs:label>
<rdfs:label xml:lang="fr">assemblee</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Interview">
<rdfs:subClassOf rdf:resource="#Meeting"/>
<rdfs:comment xml:lang="en">Meeting face to face  to ask
a series of questions usually in order to obtain
information from the interviewee. There is usually one
interviewee - person who is asked questions - and one
interviewer - person who asks the questions but there may
be more.</rdfs:comment>
<rdfs:comment xml:lang="fr">Reunion face a face pour poser
une serie de questions habituellement afin d obtenir l
information de l interviewe. Il y a habituellement un
interviewe - personne a qui l on pose des questions - et
un interviewer - la personne qui pose les questions mais
ils peuvent etre plusieurs.</rdfs:comment>
<rdfs:label xml:lang="en">interview</rdfs:label>
<rdfs:label xml:lang="fr">entretien</rdfs:label>
<rdfs:label xml:lang="fr">interview</rdfs:label>
<rdfs:label xml:lang="fr">entrevue</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Conference">
<rdfs:subClassOf rdf:resource="#FormalGathering"/>
<rdfs:comment xml:lang="en">Formal Gathering of persons
with common interests, esp. professional interests, for
the purpose of sharing information and opinions especially
through lectures and debates.</rdfs:comment>
<rdfs:comment xml:lang="fr">Rassemblement formel de
personnes avec des interets communs, particulierement des
interets professionnels, afin de communiquer des
informations et des avis particulierement par des
presentations et des debats. </rdfs:comment>
<rdfs:label xml:lang="en">conference</rdfs:label>
<rdfs:label xml:lang="en">lecture</rdfs:label>
<rdfs:label xml:lang="fr">conference</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Lecture">
<rdfs:subClassOf rdf:resource="#FormalGathering"/>
<rdfs:comment xml:lang="en">Formal Gathering  where a
Person - lecturer - teaches by giving a discourse on some
subject to a group of people  students-.</rdfs:comment>
<rdfs:comment xml:lang="fr">Rassemblement formel ou une
personne - conferencier - enseigne en donnant une
presentation sur un certain sujet a un groupe de personnes
etudiants -. </rdfs:comment>
<rdfs:label xml:lang="en">lecture</rdfs:label>
<rdfs:label xml:lang="en">course</rdfs:label>
<rdfs:label xml:lang="en">talk</rdfs:label>
<rdfs:label xml:lang="fr">cours</rdfs:label>
<rdfs:label xml:lang="fr">expose</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SocialGathering">
<rdfs:subClassOf rdf:resource="#Gathering"/>
<rdfs:comment xml:lang="en">Formal Gathering of people who
have the same or similar purposes in attending, and in
which there is communication between the participants with
sociability and maybe communal activities.</rdfs:comment>
<rdfs:comment xml:lang="fr">Rassemblement formel de
personnes qui ont le meme but en etant presents, et dans
ce lequel il y a communication entre les participants
avec, peut-etre, des activites de groupe.</rdfs:comment>
<rdfs:label xml:lang="en">social gathering</rdfs:label>
<rdfs:label xml:lang="fr">rassemblement
social</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SocialRitual">
<rdfs:subClassOf rdf:resource="#SocialGathering"/>
<rdfs:comment xml:lang="en">Social Gathering in which some
kind of ritual is performed. E.g., a wedding, an awards
ceremony, a baptism, an inauguration, a graduation
ceremony, etc.</rdfs:comment>
<rdfs:label xml:lang="en">social ritual</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="PartyEvent">
<rdfs:subClassOf rdf:resource="#SocialGathering"/>
<rdfs:subClassOf rdf:resource="#EntertainmentEvent"/>
<rdfs:comment xml:lang="en">Social Gathering at one
location for people to communicate share some experience
and to enjoy themselves.</rdfs:comment>
<rdfs:comment xml:lang="fr">Rassemblement social en un
lieu pour que les personnes communiquent, passent un
moment ensemble ou il s amusent.</rdfs:comment>
<rdfs:label xml:lang="en">party event</rdfs:label>
<rdfs:label xml:lang="fr">evenement festif</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="EntertainmentEvent">
<rdfs:subClassOf rdf:resource="#Event"/>
<rdfs:comment xml:lang="en">Event occurring primarily to
amuse or entertain Persons.</rdfs:comment>
<rdfs:comment xml:lang="fr">Evenement se produisant
principalement pour amuser ou amuser des
personnes.</rdfs:comment>
<rdfs:label xml:lang="en">entertainment event</rdfs:label>
<rdfs:label xml:lang="fr">evenement de
divertissement</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="SportsEvent">
<rdfs:subClassOf rdf:resource="#EntertainmentEvent"/>
<rdfs:comment xml:lang="en">Entertainment Event based on
sport activities.</rdfs:comment>
<rdfs:comment xml:lang="fr">Evenement de divertissement
base sur des activites sportives.</rdfs:comment>
<rdfs:label xml:lang="en">sports event</rdfs:label>
<rdfs:label xml:lang="fr">evenement sportif</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="CorporateMemoryEvent">
<rdfs:subClassOf rdf:resource="#Event"/>
<rdfs:comment xml:lang="en">Event corresponding to changes
in the Corporate Memory.</rdfs:comment>
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<rdfs:comment xml:lang="fr">Evenement correspondant aux
changements de la memoire d entreprise.</rdfs:comment>
<rdfs:label xml:lang="en">corporate memory
event</rdfs:label>
<rdfs:label xml:lang="fr">evenement de la memoire d
entreprise</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Addition">
<rdfs:subClassOf rdf:resource="#CorporateMemoryEvent"/>
<rdfs:comment xml:lang="en">Corporate Memory Event
corresponding to content added to the
memory.</rdfs:comment>
<rdfs:comment xml:lang="fr">Evenement de la memoire d
entreprise correspondant a un ajout de
contenu.</rdfs:comment>
<rdfs:label xml:lang="en">addition</rdfs:label>
<rdfs:label xml:lang="fr">ajout</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Deletion">
<rdfs:subClassOf rdf:resource="#CorporateMemoryEvent"/>
<rdfs:comment xml:lang="en">Corporate Memory Event
corresponding to content removed from the
memory.</rdfs:comment>
<rdfs:comment xml:lang="fr">Evenement de la memoire d
entreprise correspondant a un effacement de
contenu.</rdfs:comment>
<rdfs:label xml:lang="en">deletion</rdfs:label>
<rdfs:label xml:lang="fr">effacement</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Modification">
<rdfs:subClassOf rdf:resource="#CorporateMemoryEvent"/>
<rdfs:comment xml:lang="en">Corporate Memory Event
corresponding to content transformed in the
memory.</rdfs:comment>
<rdfs:comment xml:lang="fr">Evenement de la memoire d
entreprise correspondant a la modification de
contenu.</rdfs:comment>
<rdfs:label xml:lang="en">modification</rdfs:label>
<rdfs:label xml:lang="fr">modification</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Update">
<rdfs:subClassOf rdf:resource="#Modification"/>
<rdfs:comment xml:lang="en">Modification corresponding to
content changed into more recent one.</rdfs:comment>
<rdfs:comment xml:lang="fr">Modification correspondant a
la mise a jour de contenu.</rdfs:comment>
<rdfs:label xml:lang="en">update</rdfs:label>
<rdfs:label xml:lang="en">mise a jour</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="Consultation">
<rdfs:subClassOf rdf:resource="#CorporateMemoryEvent"/>
<rdfs:comment xml:lang="en">Corporate Memory Event
corresponding to a user seeking information from the
memory.</rdfs:comment>
<rdfs:comment xml:lang="fr">Evenement de la memoire d
entreprise correspondant a la consultation de
contenu.</rdfs:comment>
<rdfs:label xml:lang="en">consultation</rdfs:label>
<rdfs:label xml:lang="fr">consultation</rdfs:label>
</rdfs:Class>


<!-- Properties -->

<rdf:Property rdf:ID="SomeRelation">
<rdfs:domain rdf:resource="#Something"/>
<rdfs:comment xml:lang="en">An abstraction belonging to,
linking, or characterising of two things.</rdfs:comment>
<rdfs:comment xml:lang="fr">Une abstraction appartenant a,
joignant, ou caracterisant deux choses.</rdfs:comment>
<rdfs:label xml:lang="en">some relation</rdfs:label>
<rdfs:label xml:lang="fr">en relation</rdfs:label>
</rdf:Property>

<rdfs:Class rdf:ID="NumberableEntity">
<rdfs:subClassOf rdf:resource="#RoleEntity"/>
<rdfs:comment xml:lang="en">Entity to which one or more
numbers are associated.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite a qui l on associe un
ou plusieurs numeros.</rdfs:comment>
<rdfs:label xml:lang="en">numberable entity</rdfs:label>
<rdfs:label xml:lang="fr">entite numerotable</rdfs:label>
</rdfs:Class>

<rdf:Property rdf:ID="HasNumber">
<rdfs:subPropertyOf rdf:resource="#SomeRelation"/>
<rdfs:range rdf:resource="http://www.w3.org/TR/1999/PR-
rdf-schema-19990303#Literal"/>
<rdfs:domain rdf:resource="#NumberableEntity"/>
<rdfs:comment xml:lang="en">Number associated to a
'numberable' entity.</rdfs:comment>
<rdfs:comment xml:lang="fr">Numero associe a une entite
numerotable.</rdfs:comment>
<rdfs:label xml:lang="en">has for number</rdfs:label>
<rdfs:label xml:lang="fr">a pour numero</rdfs:label>
</rdf:Property>

<rdfs:Class rdf:ID="RoleEntity">
<rdfs:subClassOf rdf:resource="#Entity"/>
<rdfs:comment xml:lang="en">Entity that can play a role in
a relation.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite qui peut jouer un role
dans une relation.</rdfs:comment>
<rdfs:label xml:lang="en">role entity</rdfs:label>
<rdfs:label xml:lang="fr">entite de role</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ManageableEntity">
<rdfs:subClassOf rdf:resource="#RoleEntity"/>
<rdfs:comment xml:lang="en">Entity that can be
managed.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite qui peut etre
dirigee.</rdfs:comment>
<rdfs:label xml:lang="en">manageable entity</rdfs:label>
<rdfs:label xml:lang="fr">entite dirigeable</rdfs:label>
</rdfs:Class>

<rdfs:Class rdf:ID="ManagementAbleEntity">
<rdfs:subClassOf rdf:resource="#RoleEntity"/>
<rdfs:comment xml:lang="en">Entity that can manage
another.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite qui peut en diriger une
autre.</rdfs:comment>
<rdfs:label xml:lang="en">management able
entity</rdfs:label>
<rdfs:label xml:lang="fr">entite capable de
diriger</rdfs:label>
</rdfs:Class>

<rdf:Property rdf:ID="Manage">
<rdfs:subPropertyOf rdf:resource="#SomeRelation"/>
<rdfs:range rdf:resource="#ManageableEntity"/>
<rdfs:domain rdf:resource="#ManagementAbleEntity"/>
<cos:transitive>true</cos:transitive>
<rdfs:comment xml:lang="en">Relation denoting that an
entity is in charge/controls of another
entity.</rdfs:comment>
<rdfs:comment xml:lang="fr">Relation denotant qu une
entite est en charge/controle une autre entite.
</rdfs:comment>
<rdfs:label xml:lang="en">manage</rdfs:label>
<rdfs:label xml:lang="en">oversee</rdfs:label>
<rdfs:label xml:lang="en">supervise</rdfs:label>
<rdfs:label xml:lang="en">superintend</rdfs:label>
<rdfs:label xml:lang="fr">dirige</rdfs:label>
<rdfs:label xml:lang="fr">gere</rdfs:label>
<rdfs:label xml:lang="fr">supervise</rdfs:label>
</rdf:Property>

<rdfs:Class rdf:ID="AdministrationAbleEntity">
<rdfs:subClassOf rdf:resource="#RoleEntity"/>
<rdfs:comment xml:lang="en">Entity that can administrate
another.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite qui peut en administer
une autre.</rdfs:comment>
<rdfs:label xml:lang="en">administration able
entity</rdfs:label>
<rdfs:label xml:lang="fr">entite capable d
administrer</rdfs:label>
</rdfs:Class>

<rdf:Property rdf:ID="Administer">
<rdfs:subPropertyOf rdf:resource="#SomeRelation"/>
<rdfs:range rdf:resource="#OrganizationalEntity"/>
<rdfs:domain rdf:resource="#AdministrationAbleEntity"/>
<rdfs:comment xml:lang="en">Relation denoting that an
Entity -Domain- regulates the operations of an
Organizational Entity -Range-.</rdfs:comment>
<rdfs:comment xml:lang="fr">Relation denotant qu une
entite regle les operations d une entite d
organisation.</rdfs:comment>
<rdfs:label xml:lang="en">administer</rdfs:label>
<rdfs:label xml:lang="fr">administre</rdfs:label>
</rdf:Property>

<rdfs:Class rdf:ID="ActivityAbleEntity">
<rdfs:subClassOf rdf:resource="#RoleEntity"/>
<rdfs:comment xml:lang="en">Entity that can have an
activity.</rdfs:comment>
<rdfs:comment xml:lang="fr">Entite qui peut avoir une
activite.</rdfs:comment>
<rdfs:label xml:lang="en">activity able
entity</rdfs:label>
<rdfs:label xml:lang="fr">entite capable d
activite</rdfs:label>
</rdfs:Class>

<rdf:Property rdf:ID="HasForActivity">
<rdfs:subPropertyOf rdf:resource="#SomeRelation"/>
<rdfs:range rdf:resource="#Activity"/>
<rdfs:domain rdf:resource="#ActivityAbleEntity"/>
<rdfs:comment xml:lang="en">Relation denoting that an
Entity is carrying out an activity.</rdfs:comment>
<rdfs:comment xml:lang="fr">Relation denotant qu une
entite effectue une activite.</rdfs:comment>
<rdfs:label xml:lang="en">has for activity</rdfs:label>
<rdfs:label xml:lang="fr">a pour activite</rdfs:label>
</rdf:Property>

<rdf:Property rdf:ID="CreatedBy">
<rdfs:subPropertyOf rdf:resource="#SomeRelation"/>
```